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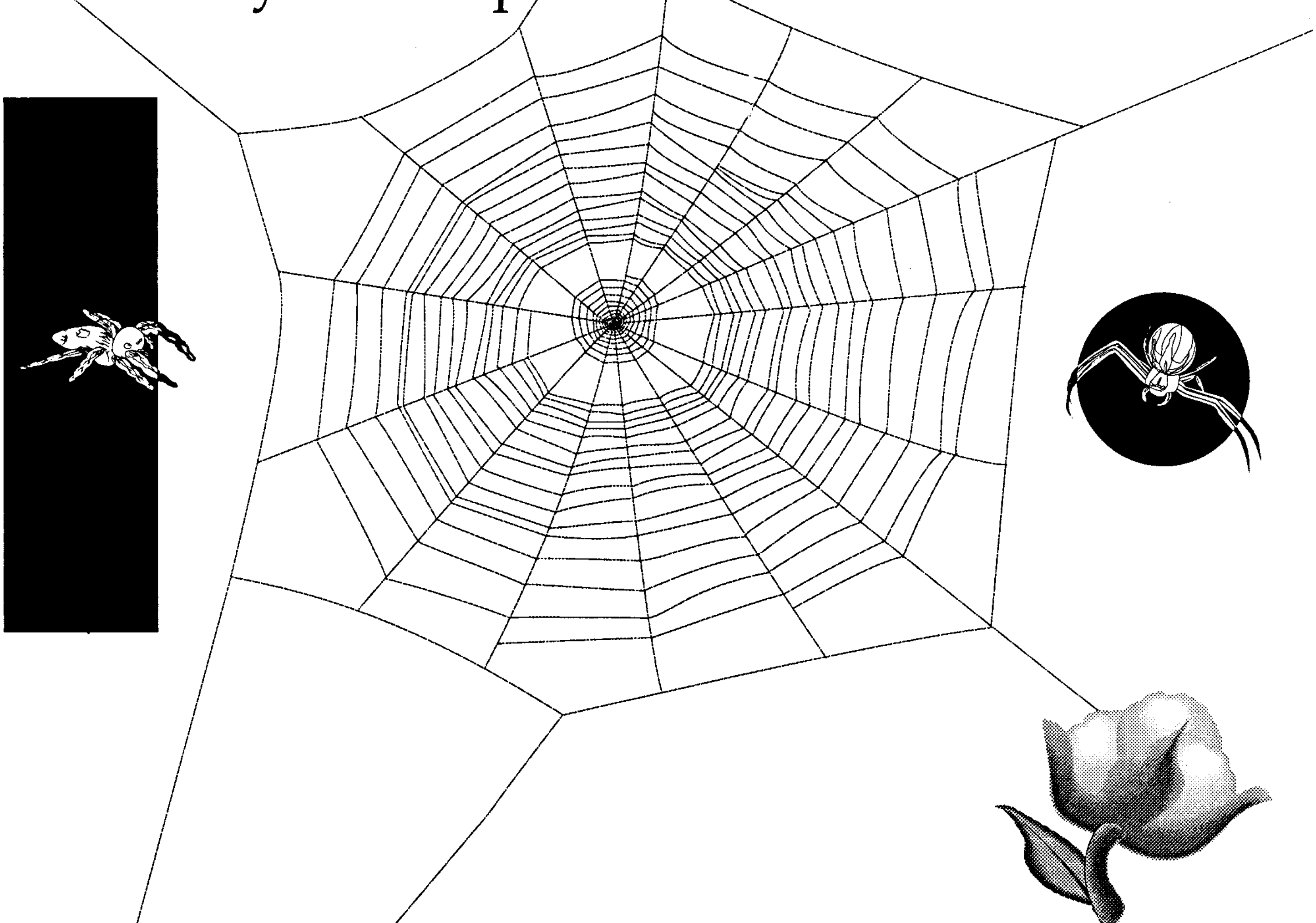
## with a Key to the Species



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# Biology, Predation Ecology, and Significance of Spiders in Texas Cotton Ecosystems with a Key to the Species

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# Contents

# Abstract

Spiders aid in the control of cotton pest insects by direct predation and through incidental mortality (e. g., aphids adhering to a spider web and suffering mortality without spider intervention). Some spider species can be key predators (causing irreplaceable mortality to a pest species) of key insect pests such as the cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter), a prey type for which spiders provide probably the most effective natural control. Most spider species serve as members of vast predator assemblages within cotton ecosystems, helping to restrict major and minor pests to low densities. Evidence suggests that arrays of spider species may act as ecological indicators of the degree to which pest insects are under control in cotton fields. Spider species have been observed feeding upon every major and most minor, secondary, or occasional insect pests of Texas cotton.

The discussion presented in this bulletin of pest categories and of appropriate corresponding biological control agents can help to unify the biological control concept for cotton and other agricultural crops. The three pest groups discussed consist of sessile external (SE) arthropod pests; sessile internal (SI) arthropod pests; and mobile, visually acute (MV) arthropod pests. Although spider predation influences all the groups to some degree, it is most effective against the MV category of pests.

A key and illustrations to all known species of spiders found on Texas cotton is provided to help in species identification. The known biology and predation ecology of each spider species found on Texas cotton is discussed both from the field experiences of the authors and from the literature.


**Note added in proof:** Platnick (1993, Advances in spider taxonomy 1988-1991 with synonymies and transfers 1940-1980, New York Entomological Society, New York, 846 pp.) changed some names before this report went to press.

| | Old | | New |
|---|---|---|---|
| Family Anyphaenidae: | *Aysha gracilis* | = | *Hibana gracilis* (Hentz) |
| Family Dictynidae: | *Dictyna consulta* | = | *Emblyna consulta* (Gertsch and Ivie) |
| | *Dictyna mulegensis* | = | *Phantyna mulegensis* (Chamberlin) |
| | *Dictyna reticulata* | = | *Emblyna reticulata* (Gertsch and Ivie) |
| | *Dictyna roscida* | = | *Emblyna roscida* (Hentz) |
| | *Dictyna segregata* | = | *Phantyna segregata* (Gertsch and Mulaik) |
| Family Linyphiidae: | *Tennesseellum formicum* | = | *T. formica* |

## Introduction

Spiders are one of the dominant arthropod groups on cotton (Whitcomb et al. 1963, Brady 1964, van den Bosch and Hagen 1966, Laster and Brazzel 1968, Leigh and Hunter 1969, Battu and Singh 1975, Fuchs and Harding 1976, Lockley et al. 1979, Bishop 1980, Bishop and Blood 1981, Dean et al. 1982, Whitcomb 1983, Mansour 1987, Nyffeler et al. 1987a, Breene 1988, Breene et al. 1989a) and in many other field crops (Nyffeler 1982a, Nyffeler and Benz 1979a, 1980a, 1987, Young and Edwards 1990). Among the pests, most lepidopteran species (in all life stages) are susceptible to spider predation. The most notable lepidopteran pests on cotton are the tobacco budworm, *Heliothis virescens* (Fab.); bollworm, *Helicoverpa zea* (L.); and cotton leafworm, *Alabama argillacea* (Huebner) (Ridgway and Lingren 1972, Room 1979, McDaniel et al. 1981). Adult moths can be captured in webs of orb weavers, comb-footed weavers, and other web-spinning spiders. Many wandering spider species that do not build a web but instead forage for prey on the cotton plant consume eggs of the bollworm/budworm complex and other lepidopterans (McDaniel and Sterling 1982, Gravena and Pazetto 1987, Nyffeler et al. 1990a). Lepidopteran larvae are also subject to predation from a wide variety of web-building and cursorial spider species. Thus, all life stages of the pest are at least somewhat vulnerable to spider predation.

Boll weevil adults, *Anthonomus grandis grandis* Boheman, have been observed taken by the green lynx spider, *Peucetia viridans* (Hentz); the jumping spider, *Phidippus audax* (Hentz); and the southern black widow, *Latrodectus mactans* (Fab.) (Whitcomb et al. 1963, Nyffeler et al. 1992c).

Spiders compose the most important predator group for the control of the cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter) (Breene et al. 1989a, b, 1990), considered by many as a key pest of Texas cotton although its true pest status is not well understood. Except for sporadic parasitism of overwintering eggs within the stems of woolly croton, very few parasitoids affect the cotton fleahopper, even in unsprayed cotton fields (Breene et al. 1989a).

The purpose of this report is to provide information on how spiders and other beneficial arthropods can be most appropriately used in cotton pest control programs. Much of the information can be extrapolated for use on other crops. A key is provided to guide the reader to the identity of the pertinent spider species. We discuss each of the 146 species of spiders found on Texas cotton individually to provide natural history information. The format of the text is intended for future revision and correction as new information becomes available.

## Materials and Methods

The spider species represented in the key were collected from cotton fields throughout Texas from 1978 to 1990 (Tables 1 to 3). Sampling methods included whole plant and D-Vac (see Dean et al. 1982 for details). Dean and Sterling (1987) sampled cotton fields throughout Texas using only D-Vac. If pitfall traps are used in areas of Texas as in east Texas, additional species would likely be found that are not included in the key. Other collection methods included sweep net, aspiration, and hand collection. The "Literature Cited" section provides a review of the available publications dealing with spiders in cotton ecosystems and elsewhere. We cite additional publications from the literature that pertain to an aspect of spider biology or behavior that adds to the content of this report. A taxonomic discussion of each of the species is also provided. We include our own observational data in the text (including unpublished material) for many of the species involved.

## Pest Categories and Corresponding Biological Control Agents

When choosing beneficial arthropod(s) with the highest probability of control efficacy on the pest under consideration, the biology and behavior of the pest should be weighed and the pest assigned (at the life stage of interest — egg, larva, adult) to one of three major arthropod pest categories:

1. Sessile external (SE) arthropod pests, stationary (sessile) or slow-moving pests found on exterior plant surfaces. Examples are mealybugs, scale insects, aphids, mites, and the eggs of many pest insects.
2. Sessile internal (SI) arthropod pests, found inside plant tissues, like boll weevils and many insects that bore.
3. Mobile, visually (MV) acute arthropod pests, such as some leafhoppers, treehoppers, many winged adult flies, bees, beetles, butterflies, and moths.

Associated beneficial arthropods have been documented as successfully controlling each group (Fig. 1).

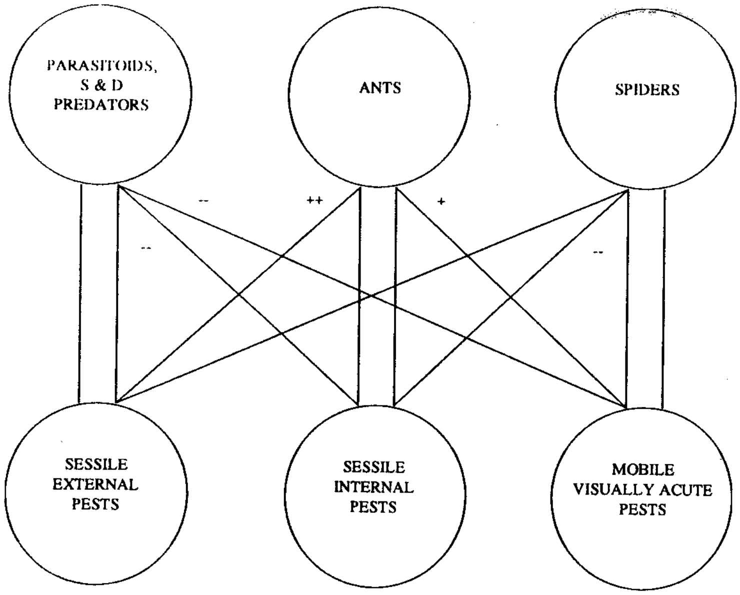


**Figure 1. Diagram of the concept of the unified biological control. The most appropriate control agent category is shown directly above the three major pest divisions. Search-and-destroy (S & D) predators include, for example, certain species within the Coccinellidae (lady beetles), Chrysopidae (lacewings), and selected heteropterans (see explanation in text). Plus or minus symbols depicted outside of a line from a control agent category indicate relative efficacy of the control agent upon the connected pest division.**

Although the idea of matching pests to natural enemies is not new, its misunderstanding in agriculture is partly due to the lack of knowledge of life histories and prey spectra for many beneficial arthropods. Many workers have insisted on assigning a pest species to a type of predator/parasitoid even though each life stage of a pest can be controlled by distinctly different taxa. Vast quantities of resources have been spent unsuccessfully to achieve control of certain pests using natural enemies having inappropriate or poorly suited biological and behavioral characteristics. Examples of this include the multidecade-long and as yet unsuccessful search for an effective boll weevil larval parasitoid (Pierce et al. 1912) and the research dealing with cotton bollworm/budworm control. Parts of the conceptual framework for the hypotheses under discussion here are relatively new, and future input data will probably provide refinement and thus save resources by preventing a mismatching of pest/prey to the predator/parasitoid.

## Sessile External (SE) Arthropod Pests

The sessile external (SE) arthropod pest category is the best known and is made up of arthropod pest species that are sessile or slow moving and found externally on above-ground plant parts. Individuals in this group spend part of their life cycle either stationary or moving slowly upon the plant. Included in this group are aphids (Aphididae and related families, although the stronger, alate adults may fall within the mobile, visually acute arthropod pests [MV] category); whitefly immatures and eggs (Aleyrodidae); many scale insects (several families within the Coccoidea); externally deposited eggs of Lepidoptera, Coleoptera, Diptera, etc.; exposed larvae (species in Noctuidae, Curculionidae, and many others); and mites (Acari). Other external phytophagous insects displaying similarly immobile or sluggish behavior and external habitats may also be placed within the SE group.

The characteristics often thought needed to control the members of this group by beneficial arthropods are the ones championed for nearly all classical biological control (Huffaker 1971, DeBach 1974, van den Bosch et al. 1982, and others) and are well known by most agricultural entomologists. Host specificity by which the predator/parasitoid attacks one or a few pest species is appropriate in classical biological control. A density-dependent, reciprocal relationship between prey and predator/parasitoid may be required, forming a low population, stable equilibrium between the two. The exhibition of a numerical response in the numbers of the predator/parasitoid to the prey numbers is often thought to be necessary (Beddington et al. 1978). A population equilibrium may be necessary to perpetuate the system for the duration of the season or on a permanent basis because, should the host specific predator/parasite kill all its prey, its own numbers would also disappear. This would enable possible recolonization and resurgence of the pest, without response by the now-absent predator/parasitoid, especially if the beneficial had been introduced and is not normally indigenous.

The mainstay beneficials used against the SE pest group are largely parasitoids from the orders Hymenoptera and Diptera, encompassing many families within each order. Most current and historical literature on biological control deals with the parameters set by the category of SE pests and the parasitoids and predators that attack them. Thorough works about most or all aspects of SE biological control and further detailed reference sources are by Huffaker (1971), DeBach (1974), Huffaker and Messenger (1976), van den Bosch et al. (1982), Hoy and Herzog (1985), Waage and Greathead (1986), Ridgway and Vinson (1987), and many others.

Predator species successfully used with this prey group tend to possess characteristics similar to parasitoids (narrow host preference range, density dependence, numerical response to prey numbers, etc.). Many, if not most of these predator species, may be considered search-and-destroy predators in the sense of Murdock et al. (1985). These search-and-destroy predators may demonstrate remarkable efficiency in seeking out and consuming certain SE prey. For example, *Chrysoperla rufilabris* (Burmeister) was noted for its persistence when attacking sweetpotato whitefly, *Bemisia tabaci* (Gennadius) (Breene et al. 1992). Biological control successes using these predators include lady beetles (Coccinellidae), lacewings (Chrysopidae), a mirid egg predator, and others (Huffaker and Messenger 1976, Ridgway and Vinson 1987). These predators are generally considered polyphagous, a characteristic considered to be negative for arthropod pest control because of diluting effects that alternative prey may have. These predators have been used successfully in situations with SE pests such as aphids and scale insects that are often found concentrated together, perhaps nullifying non-beneficial prey selection (Huffaker and Messenger 1976). *Orius* spp. (Anthocoridae) may be a similar predator type (Reid 1991). Even species of jumping spiders may be forced into monophagous behavior under conditions of very low prey species diversity (Nyffeler et al. 1990b).

When dealing with members of the arachnid order Acari, the previously mentioned characteristics are generally considered useful for natural enemies to combat pest mites. Predaceous mites are often used in the successful control of phytophagous mite pests; however, lady and rove beetles (Coccinellidae and Staphylinidae), lacewings (Chrysopidae and Hemerobiidae), and certain Heteroptera and Thysanoptera also have been used (Huffaker et al. 1970, McMurtry et al. 1970, Huffaker 1971, Luck et al. 1977, Gonzalez et al. 1982, van den Bosch et al. 1982, Wilson 1985).

The science of agricultural entomology has concentrated upon beneficial insects and mites attacking the SE pest type, and all or most of the control successes occur among this group. Most spiders do not have the characteristics thought useful in controlling this type of pest and have been largely and perhaps correctly ignored. Spiders prey upon many of the members of the SE group (aphids, eggs of various pest insects, etc.), but their efficacy upon them has largely been considered insignificant because of the apparent lack of a numerical response by the spiders to the prey (Riechert and Lockley 1984) and the spider's relatively low field numbers. Ants, although effective against certain SE pests (especially insect eggs), commonly form protective relationships with honeydew-exuding SE insect pests (aphids, mealybugs), which may or may not be agriculturally advantageous.

## Sessile Internal (SI) Arthropod Pests

The second category of pests is composed of sessile internal (SI) arthropod pests hidden internally within the plant tissues, fruit, or on underground plant parts. Members of this category primarily include eggs and immatures of certain species of the orders Lepidoptera, Coleoptera, Diptera, and Hymenoptera. Examples of SI pest species on cotton are boll weevil eggs and immatures and bollworm/budworm larvae hidden within the fruit.

Boll weevil larvae hatch from eggs oviposited by the female into the fruiting structure. The eggs are inserted into a hole made by the female's long proboscis (snout); she then seals the hole with frass (Sturm and Sterling 1986). The weevil never leaves the fruiting structure until adulthood, having spent its entire life lodged inside the fruit and protected somewhat from parasites and predators. Some parasites are equipped with ovipositors capable of reaching these pests through the plant tissue, and others insert their egg inside the fruit, where it hatches and seeks out the immature weevil. Control attempts with these parasites, however, have had limited or no success. Some of this work began around 1900, indicative of the long history of attempts to use parasites (Pierce et al. 1912). Adult boll weevils, once free of the fruiting structure, are probably better candidates for the MV category because of their ability to fly.

The bollworm/budworm differs from the boll weevil in that eggs and exposed young larvae fall into the SE pest category, while the adult moths are included within the MV pests. This demonstrates that pest categories can be distinguished only by the biology and behavior of each life stage and not systematically. The bollworm/budworm begins its life cycle externally; the adult moths lay eggs on leaves and terminals of the cotton plant. Eggs are susceptible to predators and parasitoids before hatching. After hatching, the larvae find their way into the cotton-fruiting structures (squares, blooms, and bolls), although many may feed within the terminals for a time before proceeding to the fruit. Once within a fruiting structure, they are mostly protected from natural enemies as they enter their SI period. A larva typically attacks several squares and/or bolls before pupating.

An overlap exists between this group and the SI pest category in that parasitoids with their associated characteristics can, at least theoretically, occasionally provide successful control, although this has not occurred in cotton ecosystems. The role of parasitoids appears similar to the role of spiders on SE insect pests, i. e., a reduction in pest numbers but an apparent inability to control the pests.

The beneficial arthropods recorded as being successful in controlling SI pests on cotton have characteristics deviating from those previously thought useful in biological control. Predator species that can control SI cotton insect pests such as the boll weevil not only do not have a narrow host range but also are omnivorous. These predators, in this instance the red imported fire ant, *Solenopsis invicta* Buren, lack density dependence with individual prey species and are probably unable to exhibit a numerical response. The field numbers of these predators probably do not rely on or respond in any significant manner to field pest numbers. Prey biomass of a single species is simply not enough to significantly influence ant numbers, which may reach tens to hundreds of millions of individuals per hectare of cotton ecosystem (Breene et al. 1989a). The red imported fire ant is omnivorous, feeding upon cotton nectar, animals vulnerable to it on the cotton plants, animals on the surface of the ground or throughout the soil horizon, and scavenged dead animals and seeds with high oil content. The large amount of biomass available as energy to the ants renders the biomass of each individual pest arthropod species insignificant. A stable equilibrium between pests and beneficials is not observed nor required for control of pests under these conditions. The ants control pest arthropods by a surge-and-eliminate tactic; they overwhelm them on cotton plants, attacking any insects (adults, immatures, or eggs) found on the leaves, stems, terminals, or fruiting structures and preying upon insects found inside the fruit, whether it is still on the plant or shed onto the ground (McDaniel and Sterling 1979, Agnew and Sterling 1982, Sterling 1984, Sterling et al. 1984, Fillman and Sterling 1985, Sturm and Sterling 1986, Breene et al. 1989a, b, 1990, Nyffeler et al. 1990a, Breene 1991a). When the ants sense a boll weevil larva within a fruiting structure, they make a typical jagged entrance hole into cotton squares or bolls to remove the insect feeding inside (Sturm and Sterling 1986).

Red imported fire ants will not attack all insects but tend many aphid species and other taxa (mealy bugs, scale insects) that may exude honeydew. The ants collect honeydew for food, consume parasitized individuals (Vinson and Scarborough 1991), and protect the aphids from predators (Lofgren et al. 1975, Agnew and Sterling 1982, Showler and Reagan 1987). However, red imported fire ants have been shown under certain circumstances to completely consume, or at least relocate, certain aphid species (Morrill 1978). Aphids under ant-tending conditions are probably beneficial to overall pest control on cotton because the presence of the aphids is linked to greater ant-foraging numbers on the cotton plants (Reilly and Sterling 1983). Aphid numbers have not been seen to build to greatly elevated levels under ant care, and the honeydew could be harvested before it can stain the cotton, thereby preventing a loss in cotton grade and quality. Producers considering this type of control in areas where the red imported fire ant occurs should refer to the TEXCIM computer model (Breene 1991b; Sterling et al. 1992b).

Ant interaction with arthropod pests can be found in other crops such as corn (Perfecto 1990, 1991, Brust 1991, Perfecto and Sediles 1992), sugarcane (Adams et al. 1981, Showler and Reagan 1991), forests (Youngs 1984, Campbell et al. 1991), orchards (Huang and Yang 1987, Paulson and Akre 1991), and elsewhere in the literature (e.g., predation on ticks; Harris and Burns 1972, Burns and Melancon 1977). The idea of ant utilization for applied agricultural purposes is not new but has seldom been studied.

The overall effect of spiders on the SI pest type is likely not significant.

## Mobile, Visually (MV) Acute Arthropod Pests

The final pest category is that of the mobile, visually (MV) acute arthropod pests as typified on cotton by fleahoppers; however, other insects such as orthopterans, leafhoppers, treehoppers, and adults of Lepidoptera, Diptera, Hymenoptera, and others fit into this category. Individuals of this pest type are often hypersensitive to the environment around them, ready to flee at the slightest disruption. Adult fleahoppers take flight upon perceiving a parasitoid, predator, or often even a human observer approaching; they have good eyesight and are quick to respond to movement by flight. On cotton, parasites have failed to significantly affect this pest type, especially fleahoppers. Although ants play a role in fleahopper control, at least on immatures and possibly eggs, no evidence for their predation upon adults has been observed (Breene et al. 1989b, 1990). Spiders are the best equipped of the arthropod predators to handle the MV pest type because of their superior eyesight or web utilization capabilities. Fleahoppers are susceptible to being snared from flight by web-weaving spiders, are captured by ambushing spiders, and can be seen and chased down by the swift lynx and jumping spiders. This category of pest has been studied only rarely compared with the SE, or even to the SI pest category, and few natural control successes have been noted. The major difficulty has been accurately assigning irreplaceable pest mortality to a species or a group of species under realistic conditions. Parasitoids commonly leave evidence of their efficacy upon pests through shed pupal cases and carcasses, but predators often leave no trace of their actions upon the pests (Sturm and Sterling 1986).

Most cotton producers, consultants, and many entomologists thought fleahoppers had no predators until predation ecology studies were completed on the cotton fleahopper in the 1980's (Dean et al. 1987, Breene 1988, Breene and Sterling 1988, Breene et al. 1989a, b, 1990). Spiders caused the most immature fleahopper mortality in tests by Breene et al. (1989a, b, 1990). Spiders share few of the characteristics found in the beneficial arthropods that control SE pests, although they do share many ant features. Spiders are typically not only widely polyphagous and out of synchronization with their prey but are also cannibalistic, a condition often assumed to be detrimental by agricultural biologists. Cannibalism and/or wide prey spectrums may actually prove necessary for the beneficial arthropods that control the MV pests. Spiders may therefore ensure their own continued presence in the field by their polyphagous and cannibalistic nature. They will prey disproportionately on the most abundant pests but need alternate prey sources to remain in the field when pest numbers are low. Spiders effectively control fleahoppers in cotton fields by forming species assemblages that help to keep fleahopper numbers low. Unlike situations described elsewhere (Riechert and Lockley 1984, Riechert and Bishop 1990), the presence of a single spider species such as the striped lynx spider, *Oxyopes salticus* Hentz, which is often highly abundant on cotton, may result in economic control of fleahoppers by itself, according to computer simulation models using field data in TEXCIM, delineated in Breene et al. (1989a).

As with nearly all arthropod groups, exceptions are not uncommon. The family Dryinidae is a group of wasps that parasitize leafhoppers and other MV Auchenorrhyncha (Borror et al. 1989). The females have evolved toothed chelae on the tarsi of their front legs used to grasp the leafhopper. They then paralyze the leafhopper with their sting and deposit an egg within it. However, successful biological control of leafhoppers using dryinids has not been reported.

## Interactions among Beneficial Arthropods

A plethora of literature dealing with arthropod interactions involving competition (- -, indicating a negative effect upon both individuals or whatever units are under discussion), predation/parasitism (+ -), mutualism (+ +), commensalism (+ 0), and amensalism (- 0) are available and will only be touched on lightly here (Fig. 1). Our attention is restricted to the predator-prey interactions (+ -), where the first symbol signifies a benefit to the predator by the gain of food as energy, and the second symbol a negative effect upon the prey that has given up its energy to the predator and departed the species gene pool (Polis et al. 1989). The literature shows many examples of one beneficial arthropod consuming another beneficial arthropod, and the value of the consumer predator is then questioned. Many authors suggest that a negative relationship is induced by the loss of one beneficial predator to another (e.g., Randall 1982). If large numbers of beneficials critical to the control of a particular pest are destroyed by another species that does not affect the control of the pest itself, then perhaps the problem may become economically detrimental for the agroecosystem. Otherwise, occasional cross-predation probably has little effect on pest control. It may even be beneficial to the extent that it maintains certain predators, e. g., spiders in a field. Recent interest in metapopulation research may provide more concrete answers to these questions (Taylor 1990, 1991; Hanski and Gilpin 1991; Sabelis et al. 1991).

Because this paper is primarily concerned with cotton agricultural ecosystems, focusing mainly on maximizing return while minimizing costs both to the producer (chemicals, energy) and the surrounding human community (damages caused by chemical infiltration into adjoining areas and by other pollution), a third character has been added to the interaction criteria in an attempt to interpret the overall effect of the predator interaction in terms of effects upon cotton yield. The example of predator-prey interaction would then become either + - +, + - 0, or + - -; the third character symbolizes the overall positive, neutral, or negative effect of cross-predator predation on the ecosystem's yield.

An example of overall effect upon the system from the destruction of other beneficial arthropods can be drawn from the following data. Sampling data from a cotton field under natural biological control by red imported fire ants in the Texas Coastal Bend (Breene 1991a) compared with other fields without ants or with numbers of ants too low for control show differences in the taxa of the natural enemies. In the low- or no-ant fields, predaceous bugs such as *Geocoris* spp. and *Nabis* spp. were observed throughout the season. In the field where ants and web-weaving spiders were in significantly higher numbers than in other fields, the predaceous bugs were seen only once in the early season. Plant bugs, almost exclusively the cotton fleahopper, were relatively numerous in the early season in both types of fields. They then maintained their presence in the low- or no-ant fields for the rest of the season, but disappeared from the field under ant control. Lady beetles, lacewing larvae, and pirate bugs were evident all season long in the low- or no-ant fields; however, they were rare in the field under ant control. Web-weaving spiders showed a numerical response to the presence of high ant numbers (Breene 1991a), an indication of the spiders' consumption of the ants. The red imported fire ant probably decreased the larval numbers of the lacewing and lady beetles, while the spiders were probably responsible for the low number of the more mobile *Geocoris* spp., *Nabis* spp., *Orius* spp., adult lacewings, and lady beetles. The mechanisms for the three pest categories (SI, etc.) also operate when beneficial insects are utilized as prey.

The field where pest insects were controlled by the red imported fire ant will be considered first. Predation upon *Orius*, *Geocoris*, *Nabis*, and lacewing and lady beetle adults by spider species might be + - 0 if the prey species were simply superfluous to overall pest control or + - + if they functioned to supply needed additional energy to the spiders, provided the spiders were engaged in controlling an MV pest. Ants alone are needed to control cotton insect pests, and because of this, ant predation on the lacewing and lady beetle larvae can be considered + - + as beneficial to the system because they supplied the ants with additional energy, regardless of how insignificant the amount.

Taking this one step further, after fleahopper pressure on the cotton crop decreased after first bloom and fleahopper numbers dropped, the field's spider population probably could have disappeared with no change in either the economic outcome or the status of pest insect control within the field. This did not happen because the spiders found in the ant field apparently successfully avoided ants; the ants evidently could not deal with spider webs, and the wandering spiders' physical agility decreased their probability of becoming ant prey. The web-weaving group of spiders displayed an apparent numerical response to ant numbers because more of the smaller-sized colonizers survived in the field by preying on ants and perhaps because the ants provided them a measure of protection from some natural enemy (Breene 1991b). Here, predation by the spiders upon the ants showed + - 0 because the action apparently did not significantly affect the control of the pest insects by the ants; the spiders did not significantly affect ant field numbers.

Finally, cannibalism among the spiders could also have been + - 0 because the spiders had sufficient prey. Thus the overall system did not benefit greatly through maintaining a continuous spider presence, especially in the mid to late season.

In the fields with no- or low-ant numbers and without cotton pest insect control by ants, spider predation upon other predators may show + - - or + - 0, having a net deleterious or neutral effect upon the cotton ecosystem. Measuring the values of the individual beneficial species can be difficult, and these values may overlap (Sterling et al. 1992a). These circumstances and whatever others occur in the ecosystem under examination should be considered when efforts are made to evaluate the relative worth of a beneficial arthropod species. These patterns change with temporal and geographical factors.

## Key, Secondary, and Minor Pests

Key, or primary, pests are viewed as persistent (year after year) destroyers of yield. They directly attack the most economically important plant part (the fruiting structures of cotton) and are not consistently controlled by beneficial arthropods. On Texas cotton, the boll weevil and the cotton fleahopper are generally considered key pests by producers and economic entomologists.

Secondary pests gain economic status when an interruption occurs in the beneficial arthropod complex that normally keeps them under control, often by chemical pesticide applications (insecticides and herbicides, Breene 1991a). Bollworms/budworms are typically the insect species complex most commonly thought of as secondary pests on Texas cotton.

"Occasional" and "minor" are two terms applied to a host of arthropods normally controlled by natural enemies but for various reasons sufficiently increase their numbers to reach economic levels. Some of the members of this group include aphids, whiteflies, thrips, and some lepidopteran leaf-feeding species. In some areas or under certain conditions, one of these insect species can reach key pest status. An example of this might be locations in the Texas Panhandle, where large numbers of thrips can build up on wheat consistently year after year. At wheat harvest, large numbers of them migrate onto the young early season cotton, where they have the potential to do great damage. Recently, however, the economic significance of the thrips has been doubted.

Evidence from the 1980's showed that boll weevil can be controlled by red imported fire ants if present in sufficient numbers and placed within the field in a consistent distribution (Fillman et al. 1983; Fillman and Sterling 1983, 1985; Sterling 1984). Red imported fire ants can also assist spiders in controlling cotton fleahoppers (Breene et al. 1989a, b, 1990; Breene 1991b). In cotton fields where natural biological control by red imported fire ants is occurring (Breene 1991b), boll weevils and fleahoppers are no longer an economic consideration. Therefore, in regions normally containing the red imported fire ant, a reasonable assumption may be that all cotton pest arthropods are secondary or minor pests because only perturbations of their habitat with subsequent loss of ants and other beneficial arthropods can cause outbreaks that reach economically damaging levels. The most commonly observed habitat perturbations include torrential rains and chemical intervention.

Other criteria may be needed when judging the seriousness of a pest arthropod. Examination of the number of beneficial species successful in controlling pest insects may provide some insight. The boll weevil, although attacked by natural enemies, is only reliably and predictably controlled by a single species, the red imported fire ant. A pest species controlled by only a single predator species may have great potential for economic injury compared with another pest species having many biological control agents.

The cotton fleahopper, previously thought to be controlled only by chemicals (Breene 1988), is controlled by a few of the more common spider species and red imported fire ants. This may reflect on its relative seriousness as a cotton pest — perhaps less grave than boll weevil because of the greater number of beneficial arthropod species that attack it. Conversely, the bollworm/budworm complex is effectively attacked by tens, perhaps hundreds, of beneficial arthropod species. Many of these species are at least potentially capable of economic control. Cotton fields without insecticide applications have few economic problems with bollworm/budworm.

In most cotton growing areas of Texas where red imported fire ants are normally found, economic damage to cotton by arthropod pests may simply result in habitat perturbation, especially chemical interruption. Could arthropod pests in most of the cotton-growing areas of the United States be economically deleterious solely under conditions of climatic extremes and chemical perturbation? Because scientific research into the economic benefits of ants and other predators is sparse, a forthcoming answer to this question is unlikely.

## Practical Applications

In the last few years, greatly improved methods of computer modeling have been developed that take into account beneficial arthropod species (including spiders) to predict their effects upon pest species and the reduction in damage to the cotton plant from predation. A simulation model was created that predicts the yields and the overall economics of the complex of arthropods working for and against the cotton plant. The Texas Cotton Insect Model (TEXCIM) is a cotton simulation model that uses the field numbers of the predators of the cotton fleahopper, bollworm/budworm, boll weevil, and the pink bollworm to predict the field dynamics of these cotton pests, assisting in the control decisions made by the cotton producer (Legaspi et al. 1989, Breene et al. 1989a, b, 1990, Sterling et al. 1992b). TEXCIM considers spider species found on Texas cotton, but until now, an identification key readily available to cotton producers and consultants has not been available.

In addition to the following discussion of individual spider species, we provide an illustrated key in the last part of this bulletin.

# Discussion

For each species, this section provides a discussion, a description, and information on known distribution, behavior, and prey. The literature unfortunately does not categorize many of the prey spectra descriptions of the spider species to life stage. Intuitive assumptions can be made for some. For example, listing "dipterans" as prey for a web-weaving spider species implies that the flies were winged adults (MV) and not eggs or larvae (SE, perhaps even SI).

Literature cited provides revisions of each family or genus that contains full descriptions, illustrations, and distribution maps of species represented in this text. Distributions listed in this report are from taxonomic revisions and personal collecting records for the state of Texas. Months mentioned in this text denote when the spider species was collected from cotton and do not imply that these dates are the only times of year the species are found. Further information on various species is in Kaston (1948, 1978). Some name changes have occurred since publication of earlier papers (see list of synonymy). We show only the left palp of the male genitalia and represent the ventral view unless otherwise stated. The female epigynum shows the ventral view.

Three tables displaying the relative numbers of spider species in cotton follow the key.

## Anyphaenidae: Ghost Spiders

The ghost spiders can be differentiated from other spider families by the distinctive lamelliform hairs arising from the base of the tarsal claws and the tracheal spiracle that is placed forward at least halfway from the spinnerets to the epigastric furrow. Otherwise, they can easily be mistaken for clubionids.

Noted for building a tube-web near the apex of cotton plants, where fleahoppers also congregate, *Aysha gracilis* (Hentz) can be occasionally common on cotton, unlike the remaining species in this genus. Not surprisingly, Breene et al. (1989a, b) implicated it as a fleahopper predator on both woolly croton and cotton, and Nyffeler et al. (1990a) also listed it as a predator of insect eggs. The body is yellowish, with paired dark markings lining the dorsal abdomen. The tracheal spiracle is closer to the epigastric furrow than to the spinnerets, which may help to separate it from the clubionids if the lamelliform hairs cannot be seen. The chelicerae are distinctively dark brown, similar to *C. inclusum*. The eggsac ranges in size from 5 to 8 mm and is attached to a substrate after its construction. Eggsacs contain from 134 to 196 eggs. Length of the female ranges from 6.4 to 8.4 mm; length of the male is from 5.7 to 6.5 mm. The species is found from May through September in the eastern half of Texas.

The carapace of *Teudis mordax* (O.P.-Cambridge) is a glossy reddish brown. The white dorsal abdomen is crossed by rows of darkened spots and the chelicerae project noticeably forward, especially in males. The length of the female ranges from 3.9 to 5.5 mm; length of the male is from 3.7 to 5.0 mm. The species occurs in eastern Texas.

The overall color of *Wulfila saltabundus* (Hentz) is white with dark markings on the carapace and abdomen. Leg I is long, often two or more times as long as the body (Kaston 1978). Eggsacs contain from 35 to 64 eggs. Length of the female ranges from 3.7 to 4.2 mm; length of the male is from 2.9 to 3.5 mm. The species occurs in eastern and northeastern Texas and has been collected from June through August.

Platnick (1974) published a revision of this family.

## Araneidae: Orb Weavers

The orb weavers make up one of the largest groups of spiders in terms of number of species consistently found in Texas cotton fields. Maturity for many is typically in the late summer or fall, when eggsacs are laid. Most are potentially capable of capturing cotton pest insects. Predation studies have been published for various species (Harwood 1974; Culin and Yeargan 1982; Horton and Wise 1983; Nyffeler and Benz 1978, 1979a, 1989; Nyffeler et al. 1986a, 1987b, 1989).

Immatures and smaller species may prey upon the cotton fleahopper and other diminutive-sized pests, and larger spiders are capable of preying upon boll weevils and adult bollworm and tobacco budworm moths as they maneuver around the cotton plants seeking ovipositional locations. Some orb weavers may be ineffective as predators of moths because many moths can escape from the webs of orb-weaving spiders using antipredator escape mechanisms (Eisner et al. 1964, Nyffeler and Benz 1981c).

A species not often observed on cotton is *Acacesia hamata* (Hentz), which usually builds its webs near the top of the cotton plant. As do some other araneids, this species makes the web at sundown and removes it by sunrise. The length of the female ranges from 4.7 to 9.1 mm; length of the male is from 3.6 to 4.8 mm. The species prefers wooded areas.

*Acanthepeira cherokee* Levi is an uncommon species typically seen late in the cotton season. The length of the female ranges from 8 to 10 mm; length of the male is from 6.5 to 10.9 mm. Unlike the males, females have humps low on the abdomen. The species occurs in eastern Texas.

The star-bellied spider, *Acanthepeira stellata* (Walckenaer), can at times be one of the most abundant orb weavers in cotton fields. Its abdomen is highly sclerotized (hardened) with many cones radiating from lateral areas. Its body is brown overall and the legs are yellow with brown rings. A white spot appears on the anterior portion of the abdomen. The length of the female ranges from 7 to 15 mm; length of the male is from 5 to 8 mm. Individuals may sometimes be found in the web at midday but will usually occupy a retreat at the edge of the web. The web is from 15 to 25 cm in diameter and is typically built on the upper half of the cotton plant. The species is found in the eastern two-thirds of Texas from May through September.

The orb weaver *Araniella displicata* (Hentz) was not found on Texas cotton until the late 1980's, when it was found to be a predator of cotton fleahoppers (Breene et al. 1989b). Its white abdomen has a pattern of lines and spots that become more distinct in later instars. The length of the female ranges from 4.8 to 7.2 mm; length of the male ranges from 4 to 5 mm. The species has more often been found in northern states. Wheeler (1973) and McCaffrey and Horsburgh (1980) listed prey species of *A. displicata* in habitats other than cotton.

The large, conspicuous garden spiders of the genus *Argiope* are some of the most noticeable, therefore, the best publicly known spiders. *Argiope aurantia* Lucas is generally the more common species on cotton. It spins its web between the cotton rows when the cotton has reached sufficient height. The length of the female ranges from 19 to 28 mm. The cephalothorax is encased with silvery hairs, and the dorsal abdomen has a distinctive black and yellow (occasionally orange) pattern. The length of the male ranges from 5 to 8 mm. One or more males may be observed on the upper part of a penultimate female's web in August or later, waiting for her to molt into adulthood, when courtship and mating can take place.

The eggsac, containing from 400 to 1,000 or more eggs, is pear shaped, brownish, papery, and pointed at the apex. The species is found in the eastern two-thirds of Texas and has been collected from June to August. The predation behavior on cotton was studied by Nyffeler et al. (1987b) and by Harwood (1974) in other habitats.

*Argiope trifasciata* (Forskal) is slightly smaller (length of the female ranges from 15 to 25 mm; length of the male is from 4 to 6 mm) and has a whitish to pale yellow series of lateral stripes along the dorsum of the abdomen. The shape of the eggsacs spun by each species is indicative of the species. Females may spin one or two eggsacs before they die within a few weeks of mating. The *A. trifasciata* eggsac is a brown, flat-topped, cup-shaped object and about 18 mm in diameter. More than 100 eggs may be laid within the eggsac. The species is widespread in Texas.

Both species of *Argiope* construct stabilimenta vertically on either side of the center hub. The stabilimenta is thought to function in many ways. The first way, as the name implies, is structurally although many experts doubt this hypothesis for most orb-weaving species (Foelix 1982). Other hypotheses include stabilimenta being used as camouflage, a molting platform, or as a shield against radiation from the sun (Foelix 1982). One recent hypothesis suggests that the stabilimentum serves as a bird warning to signal birds from flying into the web, saving the spider the energy of having to rebuild the web and the bird from cleaning and preening web remnants from its feathers (Eisner and Nowicki 1983). A more recent study proposes that the stabilimentum may resemble the ultraviolet frequency of flowers, thus acting to attract insect prey (Craig and Bernard 1990).

Spiders of the genus *Argiope* often capture honey bees in some locations (old fields, minimally disturbed grassland; Bilsing 1920, Nyffeler and Breene 1991), large grasshoppers (Nyffeler et al. 1987b), and other prey (Uetz et al. 1978, Horton and Wise 1983). *Argiope* spp. often exhibit a specialized predatory behavior toward adult lepidopterans (Robinson 1969) and may capture these insects in large numbers in certain habitats (Nyffeler and Benz 1982a).

The small orb weaver, *Cyclosa turbinata* (Walckenaer), can be quite common on cotton. Its prey is caught in the orb web, then wrapped; the prey carcass is hung on a vertical line radiating out from the web's center vertically instead of being discarded after consumption. Eggsacs are formed along this line. The web is renewed daily, leaving the eggsacs and prey carcasses intact (Levi 1977). Appearing nearly identical to the wrapped prey surrounding it, the spider normally stays at or near the center of the web. This orientation may camouflage the spider or act as bird-warning stabilimenta. The web is typically constructed toward the middle of the cotton plant. The length of the female ranges from 3.3 to 5.2 mm; length of the male is from 2.1 to 3.2 mm. Females have a pair of anterior dorsal humps with white pointed tubercles at the end of their abdomens, decorated with dark markings and a brownish carapace. Nyffeler et al. (1986a) in a study conducted in a Texas cotton field reported small insect prey dominated by aphids. The species also preys upon cotton fleahoppers (Breene et al. 1989a). *C. turbinata is* widespread in Texas and is found from June through September.

The species *Eriophora ravilla* (C. L. Koch) is distinctive in having a long, band-like scape on the female epigynum and a hump on the "shoulder" of either side of the top of the anterior abdomen. Coloration is highly variable. The carapace is typically red brown with white hairs, and the dorsum of the abdomen is white to dark gray, or brown to occasionally black. The length of the female ranges from 12 to 24 mm; length of the male is from 9 to 13 mm. The species prefers an open woodland habitat, where it produces a large web after dark and removes it before dawn. The spider remains suspended head down on the web at night and spends the day hidden in partly rolled leaves.

*Eustala anastera* (Walckenaer) has a hump above the spinnerets and a dorsal scalloped pattern. The length of the female ranges from 5.4 to 10 mm; length of the male is from 4 to 9.5 mm. The carapace is brown and the body is gray. It builds its web in the evening in the upper portions of the plant and removes the web by morning. The species is seen throughout Texas from May through September.

Another uncommon species of this genus, *Eustala cepina* (Walckenaer), has a yellowish to orange brown carapace that shades to gray toward the anterior. The abdomen has a distinct dorsal pattern called a folium. The length of the female ranges from 3.4 to 7.9 mm; length of the male is from 2.5 to 4.3 mm. The species is found in the eastern half of Texas.

Kaston (1978) noted that the web of *Gea heptagon* (Hentz) is typically built low to the ground, and the spider can drop out quickly and darken its colors when disturbed. The web lacks a stabilimentum, and a section may often be missing out of its lower half. This uncommon cotton spider species is found in the eastern third of Texas. The species has been collected on cotton from June to August. The length of the female ranges from 4.5 to 6 mm; length of the male ranges from 2.5 to 4.5 mm. The carapace is yellow brown with brown rings encircling the pale yellow legs. Yellow is also the background color of the dorsal abdomen. A dark patch appears on the posterior part of the abdomen. Eggsacs are flattened, ivory colored, and typically contain from 30 to 45 eggs (Sabath 1969). In one study, aphids made up about half of all insects intercepted in the webs of this species (Nyffeler et al. 1989).

*Hypsosinga rubens* (Hentz), seldom encountered on cotton, is a small orange orb weaver having black-rimmed eyes. The length of the female ranges from 2.5 to 5 mm; length of the male is about 3 mm. Nyffeler et al. (1990a) listed undetermined members of this genus as insect egg predators. The species has been found in the eastern half of Texas.

The prolateral surface of tibia III of *Mangora* has transverse rows of long feathery trichobothria and a black longitudinal line along the underside of the femora of legs I and II in the following two species. The dorsal abdomen of *Mangora fascialata* Franganillo has a pair of lengthwise black lines filled in by dark areas. The anterior of the dorsal abdomen displays a small median black spot. The length of the female ranges from 3.2 to 3.6 mm; length of the male is about 2 mm. The species is found in the eastern half of Texas.

*Mangora gibberosa* (Hentz), typically found on the top half of the cotton plant, builds an elaborate web (30 to 40 cm in diameter) that can vary in orientation from vertical to horizontal. Spiral sticky lines are very close together, making the web fine meshed. Eggs are hidden in rolled-up leaves. The length of the female ranges from 3.4 to 6 mm; length of the male is from 2.5 to 3.2 mm. On top of the abdomen, two longitudinal lines begin in the middle and continue posteriorly toward the end. This species is found in the eastern half of Texas from June to September and is more commonly seen in fields than in wooded areas. The prey of *M. gibberosa* includes red imported fire ants (Nyffeler et al. 1988b).

The basilica spider, *Mecynogea lemniscata* (Walckenaer), is occasionally observed on cotton, where it spins a dome-shaped web (without sticky silk), typically near the top of the plant. It builds an irregular-shaped web or labyrinth near the domed orb, where it resides. The shape and placement of eggsacs are often an indicator of the species. A *Mecynogea lemniscata* female strings her eggsacs together vertically and hangs them from the web. Carico (1984) reported that some females cut and gather their web about a central eggsac string before wrapping it tightly around the eggsacs hanging from the center of the web, apparently reducing spiderling mortality. The length of the female ranges from 6.3 to 8.6 mm; length of the male is from 4 to 6.6 mm. A black line runs longitudinally through the yellow cephalothorax. The dorsal abdomen displays a distinct foliar pattern composed of olive green, yellow, white, and black markings. The species is found in the eastern two-thirds of Texas in May and June on cotton. The species has been found paralyzed in the cells of mud dauber wasps. Wise and Barata (1983) investigated the prey of *M. lemniscata* in nonagricultural habitats.

Another uncommon visitor to cotton fields is *Metazygia wittfeldae* (McCook). The length of the female ranges from 6 to 10 mm; length of the male is from 5 to 7 mm. The species has a yellow abdomen marked with a brown pattern consisting of pairs of dark marks diverging posteriorly. The carapace grades from yellow on the back to a dark brown in front. The species builds a new web after dark before destroying the old one. The discarded web is later consumed or otherwise disposed of. *M. wittfeldae* has been found in central, eastern, and southern Texas.

Two species of the genus *Micrathena* are occasionally found in cotton fields, typically in the early season, and both occur in the eastern half of Texas. Members of the genus are diurnal; both species have a brown carapace and hardened, distinct conical abdominal tubercles.

*Micrathena gracilis* (Walckenaer) females are from 7.5 to 11.5 mm long with 10 short abdominal spines. Their colors can vary greatly, from mostly white to almost totally black. Males are about 5 mm in length, and the abdomen is white and elongate. The species has been noted mostly in heavily wooded areas, where the adults are active during the summer.

*Micrathena sagittata* (Walckenaer) has two large conical tubercles making the body arrowhead shaped. Females possess three pairs of abdominal spines and display bright yellow to orange dorsal abdomens. The male abdomen is black, except the lateral sides are white. The length of the female ranges from 8 to 9 mm; length of the male is from 4 to 5 mm. Eggsacs are fluffy white spheres 12 mm in diameter, usually containing about 90 eggs. They are most often observed along the edges of forests and in brushy areas, where their webs are rarely more than 60 cm (2 ft) above the ground (Fitch 1963). *M. sagittata* has been noted preying largely upon leafhoppers. Uetz and Biere (1980) reported a prey spectrum composed primarily of Diptera, Hymenoptera, Coleoptera, and Homoptera in nonagricultural habitats. Both *Micrathena* species can prey upon cotton fleahoppers and other mobile, visually acute pests. *M. sagittata* is present in eastern, central, and southern Texas.

*Neoscona arabesca* (Walckenaer) can be abundant. The length of the female ranges from 5 to 12 mm; length of the male is from 4 to 9 mm. Paired black spots line the yellow and brown abdomen on the rear portions. The species is found largely in sunny, moist habitats throughout Texas. The eggsac is a lens-shaped case, 10 mm in diameter, and containing about 280 eggs. The species is widespread throughout Texas, where they have been collected from May through September.

Nyffeler et al. (1989) noted aphids and beetles were significant components of the prey spectrum of *Neoscona arabesca* in Texas cotton, and Culin and Yeargan (1982) reported prey species of *N. arabesca* from soybean. Whitcomb et al. (1963) found *Neoscona* spp. capturing noctuid moths in cotton fields in Arkansas. A species of

*Neoscona* on Chinese cotton was studied by Zhao and Liu (1986).

*Neoscona utahana* (Chamberlin) is rarely seen in cotton fields but is found throughout Texas. The length of the female ranges from 8.8 to 10.4 mm; length of the male is from 6.2 to 8 mm. Both sexes have a folium on the abdomen.

Further information on all species in this family can be found in the araneid revisions (Berman and Levi 1971, Edwards 1986, Levi 1968, 1970, 1971, 1974, 1975, 1976, 1977, 1978, 1980).

## Clubionidae: Sac Spiders

Clubionids are similar to anyphaenids except the tracheal spiracle is near the spinnerets. They build tube webs at the base of cotton fruit or near the edges of leaves. Some are found more often on the ground.

Called ant spiders by Fitch (1963), members of the genus *Castianeira* mimic ants and possibly also velvet ants (mutillid wasps), both in their form and behavior. They forage on the ground in leaf litter, other organic debris, rocks, and fallen logs, raising and lowering their abdomens and front legs, the latter imitating the antennae of ants. Like *Micaria* (Gnaphosidae), they attach their eggsacs (flattened disk-shaped objects often having a pearly sheen) to the underside of stones. Some authors have placed *Castianeira* in the family Corinnidae.

*Castianeira crocata* (Hentz) has a dark maroon to black carapace with short yellow white hair posteriorly and an abdomen with a small anterior dorsal sclerite on a pattern of red orange with black plumose hairs. A wide median stripe of bright red orange runs from the back of the sclerite to the spinnerets on the abdomen. Length of the female ranges from 6.6 to 10.4 mm; length of the male is from 5.2 to 6.8 mm. The species is found in southern and southeastern Texas. The male palp is not illustrated in the revision but is identical in shape to *C. floridana* (Banks) although more robust.

*Castianeira gertschi* Kaston has a light orange carapace with a darker orange dorsal abdomen grading into a more dusky posterior with two transverse white stripes. The male has a large dorsal sclerite on the abdomen. Length of the female ranges from 5.1 to 6.3 mm; length of the male is from 4.5 to 5.5 mm.

*Castianeira longipalpus* (Hentz) can be separated from the other species by the multiple but indistinct white transverse bands on the dorsal abdomen. The carapace is reddish brown, and males have a full dorsal sclerite on their abdomen. The eggsacs are white and disc shaped with eight or nine eggs (Montgomery 1909). The length of the female ranges from 7 to 10 mm; length of the male is from 5.5 to 6.1 mm. The species occurs in the eastern half of Texas from May to August.

*Cheiracanthium inclusum* (Hentz) is the most economically important sac spider species on Texas cotton. The species was found to be a predator of the cotton fleahopper (Breene et al. 1989b) and other pests (Gravena and Sterling 1983, Nyffeler et al. 1990a). Peck and Whitcomb (1970) reported that male *C. inclusum* completed 4 to 10 instars before molting into adults (mean 112 days), and most matured after the fifth or sixth stadia. Females took 5 to 10 instars to reach adulthood (mean 142 days), most maturing after the sixth or seventh instar. Laboratory-raised mature males lived an average of 43 days, and females an average of 70 days (Peck and Whitcomb 1970). Females produced from 1 to 5 eggsacs over their life cycle, each with a mean of 38 eggs. The pale yellow, round eggs are visible within the thin, oblate spheroid eggsac. The female makes a more tightly woven brood cell and remains inside with the eggs (Peck and Whitcomb 1970). The color of the prey eaten determines the abdominal shade of individuals, which normally are light yellow or occasionally light green with dark brown chelicerae. The species has a distinct lanceolate mark on the top of the abdomen. The length of the female ranges from 4.9 to 9.7 mm; length of the male is from 4.0 to 7.7 mm. They are found throughout Texas from May through September.

Although not found in Texas cotton, *Cheiracanthium mildei* L. Koch was introduced into the northern United States and has been observed preying upon the spotted tentiform leafminer, *Phyllonorycter blancardella* (Fab.), an important pest of apple and greenhouse crops (Corrigan and Bennett 1987). Mansour et al. (1980a, b) found *C. mildei* to be the most numerous member of a group of spiders described as playing an "important role in the suppression" of the Egyptian cotton leafworm, *Spodoptera littoralis* (Boisduval), on apple in Israel. The eggs and larvae of the two cotton leafworm species are SE pests and as such, may be more effectively controlled by parasitoids or search-and-destroy predators. However, nocturnal spiders, such as *C. mildei*, which hunt primarily by touch, may have many characteristics in common with insect search-and-destroy predators.

Peck and Whitcomb (1970) observed that *C. inclusum* "becomes aware of a suitable prey organism when its fore tarsi or palpi touch it" as opposed to becoming aware of prey location by web vibration or eyesight. If *C. mildei* operates the same way, predation on leafminers and arthropod eggs would be expected, because the pedipalps and fore tarsi either receive and recognize vibrations or receive a chemical signature or both.

Various species of *Cheiracanthium*, including *C. inclusum*, have been implicated in human envenomation (Gorham and Rheney 1968, Ori 1977, Allred 1980, Newlands et al. 1980). Kaston (1948) noted the bite of *C. inclusum* to be no worse than a bee or wasp sting. The senior author of this report was bitten by an adult male of this species but suffered no ill effects. However, Spielman and Levi (1970) implicated *C. mildei* as causing necrotic skin lesions in humans.

The genus *Clubiona* differs from other clubionids in its long tarsal claws and prominent claw tufts. For *Clubiona pikei* Gertsch, Provencher and Coderre (1987) supplied data on functional response and prey switching between two species of aphids. Aphids, being SE pests, however, are probably an inappropriate prey type for control by sac spiders if for no other reason than the usually low spider field numbers versus the high reproductive potential of the aphids.

Kaston (1978) notes *Clubiona abboti* L. Koch as being the most common of the smaller species in this genus, but it is not often observed on cotton, being found on the ground and throughout the plant. The species is listed among the predators of insect eggs (Nyffeler et al. 1990a). The spider is yellow to creamy white. Length of the female ranges from 4 to 5.4 mm; length of the male is 3.7 to 4.4 mm. *Clubiona abboti* are found in northern, eastern, and central Texas from May to August.

Described as small, secretive, and fast moving with iridescent scales by Fitch (1963) and Kaston (1978), *Phrurotimpus* spp. have black marginal stripes and dark median stripes on a carapace with a brown to yellowish background. Length of females ranges from 2 to 3.6 mm; length of the male is from 1.7 to 2.8 mm. Eggsacs are red and lens shaped, and the female abandons them under stones (Kaston 1978). When not running, these spiders flex their legs, concealing the cephalothorax. Some authors now place this genus in Liocranidae.

*Trachelas deceptus* (Banks) is differentiated from the other species in the genus by the posterior row of eyes being straight, not recurved. The cephalothorax is ruddy brown and densely covered with small depressions. The abdomen is light gray to yellow, and the legs grade darker from leg I to leg IV. The length of the female ranges from 3.4 to 4.1 mm; length of the male is from 3.1 to 4.1 mm. The species has been collected from June to August in the eastern two-thirds of Texas and is listed as a predator of insect eggs (Nyffeler et al. 1990a).

*Trachelas volutus* Gertsch is similar to the previous species except larger. The length of the female ranges from 6.1 to 7.3 mm; length of the male is from 4.8 to 6.1 mm. The species occurs in the eastern two-thirds of Texas.

Some members of the genus *Trachelas* have been suspected of human envenomation (Uetz 1973, Pase and Jennings 1978). Some authors place *Trachelas* in the family Corinnidae.

For more information and generic revisions, see Kaston (1948), Edwards (1958), Reiskind (1969), and Platnick and Shadab (1974a, b).

## Dictynidae: Mesh Web Weavers

The dictynids are small, nondescript spiders that make irregular mesh webs on the cotton plant. Female dictynids produce multiple, snowy white lens-shaped eggsacs that are suspended in webbing, each containing just a few eggs. Dictynids, like uloborids, use the calamistrum to comb out silk from a sieve-like plate just forward of the other spinnerets called the cribellum.

*Dictyna annexa* Gertsch and Mulaik sports an orangish brown carapace and has whitish and gray patterns on the abdomen. The female is about 3.2 mm long; the male is about 3.5 mm long. The species is widespread in Texas.

*Dictyna consulta* Gertsch and Ivie has a pale, yellow brown cephalothorax with an abdomen similar to *D. annexa*. The female is about 2.3 mm long; the male is about 2.0 mm long. It is found largely in the western half of Texas in August and September.

*Dictyna mulegensis* Chamberlin occurs in southern and western Texas and has a dark-sided orange carapace and an abdomen with markings similar to *D. annexa*. The female is about 3.0 mm long; the male is about 2.8 mm long.

*Dictyna reticulata* Gertsch and Ivie has a pale yellow brown carapace darkened laterally and a milky white to gray abdomen. The female is about 3.0 mm long; the male is about 2.8 mm long. Occurring largely in southern and western Texas, *D. reticulata* has been reported as an important predator of cotton insects in California (Kaston 1978).

*Dictyna roscida* (Hentz) has a light to dark orangish brown cephalothorax, a pink to bright red abdomen, and is found in central and eastern Texas. The female is about 2.2 mm long; the male is about 2.2 mm long.

By far the most common species on cotton is *Dictyna segregata* Gertsch and Mulaik, which is found in the eastern half of Texas from May to September. This species has orange coloration grading to dark on the sides of the carapace, and the abdomen has whitish and gray markings. The length of the female is about 2.6 mm; length of male is about 2.5 mm. Its mesh web is often observed in the terminals of cotton; however, Whitcomb et al. (1963) noted that webs were also built close to the ground, and the species is commonly captured in surface pitfall traps. They also may build webs on the tops and bottoms of leaves. When the webs are built within terminals, the spiders are in an excellent position to capture cotton insect pests such as the cotton fleahopper (Breene et al. 1989a) and bollworm/budworm larvae. Nyffeler et al. (1988a) found that the prey of *D. segregata* was made up chiefly of aphids and small adult dipterans in an eastern Texas cotton field; however, cotton fleahoppers and other pests were scarce in 1985 when those field observations were made. In a more recent study, cotton fleahoppers were frequently captured in the webs of *D. segregata* in a cotton field in central Texas (Nyffeler et al. 1992b).

The last species of this family found to date on cotton is *Dictyna volucripes* Keyserling. It has a dark brown carapace and a whitish to brown abdomen. The female is about 3.3 mm long; the male is about 2.7 mm long. It has been found in the eastern two-thirds of Texas in May and June. Eggsacs typically contain about 15 eggs. Studies completed on *D. volucripes* in alfalfa (Wheeler 1973) and guar (Rogers and Horner 1977) listed prey as being small dipterans and wasps, thrips, and pirate bugs (*Orius*).

Wheeler et al. (1990) studied the biology of *D. coloradensis* Chamberlin and *D. major* Gertsch in Idaho. Chamberlin and Gertsch (1958) revised the family.

## Filistatidae: Crevice Spiders

*Kukulcania hibernalis* (Hentz) occasionally visits cotton fields in the eastern half of Texas and normally builds its snare in cracks and crevices of houses, barns, and outbuildings. In cotton fields, it builds its web from a crack in the soil or from under a stone, but typically on or near the ground, normally coming out only at night or when attacking prey. The crevice spiders build a tube-like central retreat from which they spin trap threads radially to detect the movement of insects over them. When a passing arthropod contacts a trap thread, the apparently poorly sighted spider runs out after the potential victim, following the clues of vibrations on the thread. After a few weeks of occupancy, the web may start to appear similar to the funnel-weavers' web, becoming thickened and sheet-like. The females are uniformly brown to blackish, and the males are yellowish tan to light brown with distinctive long, spindly pedipalps. Further information can be found in Comstock (1940), where the crevice spider was included in the genus *Filistata*.

People unfamiliar with spider morphology often mistake male crevice spiders for the brown recluse spider. Unlike the brown recluse, crevice spiders have eight eyes close together versus the six of the recluse, and the crevice spider has no trace of a violin-like shape on the dorsal side of the cephalothorax (Williams et al. 1986b). Male crevice spiders do, however, have a short, dark brown stripe immediately behind their eyes (Edwards 1983). Females can be quite large with a body as long as 20 mm. Males measure about 10 mm. Upon maturity, the males can be seen out in the open in buildings and around outside walls, where they seek females. The males usually die within a few weeks of mating. They are not known to bite unless strongly provoked.

Crevice spiders, though not often observed in cotton fields, have been occasionally found there (Whitcomb et al. 1963, Whitcomb and Bell 1964, Aguilar 1977, Dean et al. 1982, Heiss et al. 1988). They probably affect the pest insect population only minimally but are at least potentially capable of capturing bollworm/budworm moths and larvae, boll weevil adults, fleahoppers, and many secondary or minor pests that may encounter their web.

## Gnaphosidae: Ground Spiders

The Gnaphosidae have been captured in cotton fields mostly in pitfall traps and by aspiration techniques, where, as their name implies, they are found on the ground surface or in leaf litter and other similar organic material. No gnaphosids except for one species of *Drassyllus* have been found in significant numbers in cotton fields. The Gnaphosidae, like the lycosids, are at least potentially important in the cotton pest insect predation ecology.

Both species of *Drassyllus* have a preening comb on the underside of the distal end of metatarsus III and IV. The first species, *Drassyllus inanus* Chamberlin and Gertsch, has an orange to dark brown carapace and typically a grayish abdomen. The length of the female ranges from 2.3 to 2.6 mm; length of the male is from 2.0 to 2.4 mm. The species occurs in the southern half of Texas from June to September.

The most common gnaphosid observed in Texas cotton fields is *Drassyllus notonus* Chamberlin. Its dorsal abdomen is brownish gray, and the male has a lustrous orange scutum toward the front and a brown carapace. Length of the female ranges from 2.8 to 3.1 mm; length of the male is from 2.2 to 2.9 mm. The species is found in eastern and northern Texas, where it has been collected from May through September.

*Gnaphosa* are nocturnal hunters. Females are often found with flattened eggsacs containing as many as 250 eggs. *Gnaphosa altudona* Chamberlin has a murky brown carapace and an abdomen encased with fine hairs of a dark gray to blackish hue. Length of the female ranges from 3.0 to 5.1 mm; length of the male is from 3.1 to 4.0 mm. The species inhabits the southern half of Texas.

*Gnaphosa sericata* (L. Koch) has a red orange carapace and dark, fine hairs that jacket the dark gray to black abdomen. Length of the female ranges from 4.4 to 6.1 mm; length of the male is 4.0 to 4.6 mm. This species is found throughout Texas from June through August.

*Micaria* spp., recently transferred from the Clubionidae, are active ground hunters and have been often noted as ant mimics. They have been collected in July. *Micaria deserticola* Gertsch is one of the three members of the genus found in cotton. This species has a dark brown carapace and a black abdomen adorned with iridescent silver scales. Length of the female ranges from 3.1 to 3.6 mm; length of the male is from 2.5 to 3.1 mm. The species is found in the western two-thirds of Texas.

*Micaria longipes* Emerton is brownish yellow with gray hairs and covered with iridescent scales that are lost when preserved in alcohol. The abdomen has four characteristic white spots, and the posterior half grades into black toward the spinnerets. The length of the female ranges from 4.4 to 5.5 mm; length of the male is from 3.7 to 4.8 mm. The species occurs throughout Texas.

*Micaria vinnula* Gertsch and Davis has a dark reddish brown carapace and a dusky abdomen covered with inconspicuous scales. Length of the female ranges from 1.8 to 2.3 mm; length of the male is from 2.0 to 2.4 mm. The species is found only in central and southern Texas.

*Nodocion floridanus* (Banks) has a light brown cephalothorax and a gray to brown abdomen covered anteriorly in males by a large orange scutum. The length of the female ranges from 5.5 to 8.5 mm; length of the male is from 4.3 to 5.6 mm. The species occurs in the eastern two-thirds of Texas.

*Sergiolus ocellatus* (Walckenaer) has an orange carapace. The abdomen has transverse white to orangish bands on a dark gray to black field. The length of the female ranges from 4.9 to 6.7 mm; length of the male is 4.1 to 5.2 mm. The species is found in central and eastern Texas.

*Synaphosus paludis* (Chamberlin and Gertsch) has an orange carapace and a light gray abdomen. The length of the female ranges from 4.5 to 6.1 mm; length of the male is from 4.0 to 5.2 mm. It occurs in the eastern half of Texas.

*Talanites captiosus* (Gertsch and Davis) was recently transferred from the genus *Rachodrassus* (Platnick and Ovtsharenko 1991). The species has two distinctive dorsal spines on tibia IV and a light orangish-brown carapace, darkest posteriorly with many recumbent black setae and a lengthwise thoracic groove. Length of the female ranges from 3.1 to 4.4 mm; length of the male is 3.3 to 4.1 mm. Its distribution includes southern Texas.

Revisions of this family can be found in Heiss and Allen (1986) and Platnick and Shadab (1975, 1976, 1980, 1981, 1982, 1988).

## Hahniidae: Sheet Web Weavers

Hahniids build their delicate, sheet webs (rarely more than 5 cm across) on the soil surface in small depressions. The webs become visible when covered with morning dew. They have been noted in Arkansas cotton fields (Whitcomb et al. 1963, Whitcomb and Bell 1964, Heiss et al. 1988) and on Texas cotton (Dean et al. 1982).

The species found in Texas is *Neoantistea mulaiki* Gertsch. The length of the female ranges from 4 to 4.8 mm; length of the male is somewhat larger. The legs are banded, the carapace is reddish brown and shiny, and the top of the abdomen has six pale chevrons. The eggsacs, composed of circular mounds covered by white silk about 4 mm in diameter, contain about seven eggs. This species has been collected in May and July. Nyffeler et al. (1988b) reported many red imported fire ant carcasses in the webs of a *Neoantistea* sp. in an eastern Texas cotton field.

Opell and Beatty (1976) last revised the family.

## Linyphiidae: Line-Weaving Spiders

Members of the Linyphiidae family are also known under the common names of sheet-weaving and dwarf spiders. Many linyphiids are quite small, inconspicuous spiders found in every niche in the cotton ecosystem from cracks and depressions in the ground to the top of the full-grown cotton plant. Unless heavy dew makes their typically numerous webs visible, most will escape notice. They generally prefer shady areas for web building. Linyphiid spiders occur in high numbers in winter wheat fields, grasslands, and forest ecosystems in more northern geographic regions (Nyffeler 1982b, Nyffeler and Benz 1988b, Nyffeler and Breene 1992). Because of their small size, the systematic research yet to be completed in this family is perhaps greater than in any other spider family. Many arachnologists consider the Linyphiidae the most difficult of the spider families to identify.

*Ceraticelus* spp. are yellow to orange, and adults are about 1.5 mm in length.

*Ceratinops* spp. (length of the female, about 1.9 mm; length of the male, about 1.8 mm) are distributed in northern and eastern Texas. The rugose carapace is dark brown, and the abdomen is dark gray to black. It normally makes its web on the ground.

*Ceratinopsis* spp. (adult length ranging from 1.5 to 2 mm) are yellow to orange, some with a dark orange scutum.

*Eperigone eschatologica* (Crosby) has an orange brown carapace and a gray to black abdomen. The length of the female ranges from 2.75 to 3.25 mm; length of the male is from 1.9 to 2.5 mm. The species is widespread in Texas from May through August.

Two species of *Erigone* are tiny spiders (generally 2 mm or less in length) found on cotton in the eastern half of Texas. *Erigone autumnalis* Emerton (female and male length about 1.5 mm) has a gray to orange abdomen and a reddish orange carapace but without the teeth on the edge of the carapace. Found from May through September, making webs in leaf litter or on the surface of the ground, it is the most abundant species on cotton. *E. autumnalis* is a skilled and frequent ballooner (Dean and Sterling 1990). *Erigone* spp. use their fragile webs to capture small, soft-bodied insects such as dipterans and aphids (Nyffeler and Benz 1982b, 1988b).

The male *Erigone dentigera* O.P.-Cambridge (length of adults is approximately 2.1 mm) has a gray abdomen and a reddish orange carapace armed with a row of small teeth on the margin. The species is found on cotton terminals, although rarely.

The bowl and doily spider, *Frontinella pyramitela* (Walckenaer), is so named because of the distinctive shape of its web, a bowl-shaped structure apparently resting upon a doily-like construction. The species is found across the United States and can become abundant in brushy habitats and forests. Although found mostly in the eastern half of Texas, the species is not often seen on cotton. Fitch (1963) and Levi et al. (1968) mentioned pairs of this species together apparently sharing a web; however, in her review of social arachnids, Buskirk (1981) did not note social behavior associated with the species. The length of the female ranges from 3.0 to 4.0 mm; length of the male is from 3.0 to 3.3 mm. The carapace is brown, and patterns characteristic of the species are on the dorsal abdomen. Nyffeler et al. (1988a) found that this spider captures small, winged insects (primarily aphids) in a cotton ecosystem in eastern Texas.

*Grammonota texana* (Banks) (length of the female ranges from 2.8 to 3.8 mm; length of the male is about 2.3 mm) is a predator of cotton fleahoppers (Breene 1988, Breene et al. 1988a, 1989a, b). This small species prefers to build webs in the terminals of cotton and woolly croton. The cephalothorax is orange yellow and the abdomen yellow gray with a median longitudinal dark stripe. Few individuals are encountered in most years, but occasionally the species can be common. Its known distribution is the eastern half of Texas, where it appears from May through August.

The genus *Meioneta* is another uncommon visitor to Texas cotton. The length of the female is about 2.0 mm; length of the male is from 1.5 to 1.8 mm. The male has a chevron-shaped white stripe on the dorsal abdomen that points toward the cephalothorax. The web is made on the lower regions of the cotton plant.

*Tennesseellum formicum* (Emerton) has an orange yellow carapace and a whitish abdomen encircled by gray bands at front and rear. The length of the female ranges from 1.8 to 2.5 mm; length of the male is from 1.8 to 2.4

mm. It makes its web upon a leaf in the middle of the cotton plant. According to Wheeler (1973), collembolans and aphids were often caught in the webs of *T. formicum* in alfalfa fields. The species is found in the eastern half of Texas from May through September.

*Walckenaeria spiralis* (Emerton) has an orange brown to brown carapace and a dark abdomen. The length of the female ranges from 2.0 to 2.6 mm; length of the male is from 1.9 to 2.2 mm. The species occurs in northern and eastern Texas.

The biology and predation ecology of the linyphiids of Texas cotton are not well known; however, the family may be important in the control of pest insects. Further information on linyphiid spiders as predators of insect pests can be found in Pointing (1966), Jennings and Pase (1986), and Sunderland et al. (1986). Though some revisions are outdated, they are still useful: Bishop and Crosby (1932), Crosby and Bishop (1925, 1928, 1933), Kaston (1948), and Millidge (1983, 1987).

## Lycosidae: Wolf Spiders

The lycosids, pisaurids, and certain philodromids have a tapetum in their eyes that reflects light at night. A good way to find spiders with a tapetum is by holding a powerful flashlight out from the observers face as close to the eyes as possible or by wearing a miner's light pointed outward from the lower forehead (Whitcomb et al. 1963). A sharp pinpoint of greenish light may then be seen from the eyes of the spiders roaming over the ground or vegetation, often from great distances (40 m or more). Common red-green color blindness in the observer may eliminate perception of green, making the bright point of light emanating from the spider's eyes appear to be white or colorless, virtually the same as a drop of water.

Wolf spiders are caught most often in Texas cotton fields in pitfall traps (Table 3), which provide little information on the number of individuals in a given area. Muma (1973) discusses the limitations of traps but states that they can provide useful data.

The wolf spiders in the genera *Hogna, Rabidosa,* and *Varacosa* used to be included in the genus *Lycosa*. These large wolf spiders prey upon a wide variety of arthropod species, including some hard-bodied insects and other spiders (Kuenzler 1958, Whitcomb et al. 1963, Nyffeler et al. 1986a, Hayes and Lockley 1990). Predation on noctuid moths has been observed by Whitcomb et al. (1963).

*Allocosa absoluta* (Gertsch) is a rarely witnessed visitor to Texas cotton. Length of the female ranges from 3.4 to 6.8 mm; length of the male ranges from 2.8 to 4.6 mm. The sexes are similar in coloration; the carapace is dark red brown to black and has a pale median band with yellow to yellow orange mottling. The abdomen is dull yellow with black spottings. This species has been collected in May from pitfall traps in the eastern half of Texas.

*Hogna antelucana* (Montgomery) is a brownish-orange species with a white line extending from the ocular area to the pedicel. The length of the female ranges from 14 to 19 mm; length of the male is from 13 to 18 mm. This species has been collected from May through September in the northern half of Texas and is among those listed as predators of insect eggs (Nyffeler et al. 1990a).

*Hogna helluo* group nr. *georgicola* is a large, dull yellow to greenish-brown wolf spider. The length of the female ranges from 18 to 21 mm; length of the male is from 10 to 12 mm. Hayes and Lockley (1990) noted that this woodland species was found more often at the periphery of the cotton fields in the Delta region of Mississippi, where it is uncommon, as is also true for the species in Texas.

The genus *Pardosa* is a large group of spiders that are difficult to distinguish from one another. They are commonly captured in pitfall traps and are found on the plant during the day but more often at night. Certain *Pardosa* species have been observed to be nocturnal in cotton fields near College Station, where they remained on or near the ground during daylight hours and began to forage on cotton plants at dusk and most of the night (Breene et al. 1989b). This may be unusual for members of *Pardosa* in general because the genus has largely been noted in the literature as diurnal, not nocturnal, predators. *Pardosa* spp. feed on small prey from various insect orders, including aphids (Nyffeler and Benz 1981b, 1988a, Dean et al. 1987, Nyffeler and Breene 1990a).

The wolf spider *Pardosa atlantica* Emerton has a carapace lined with dark orange or yellow median and submarginal areas and a pair of dark brown longitudinal bands flanking the median area. Males have a dorsal cover of reflective white setae on the patella and tibia of the pedipalp. The length of the female ranges from 3.5 to 4.5 mm; length of the male is from 3.3 to 3.8 mm. It has been found only occasionally on cotton from eastern Texas from July through September.

*Pardosa delicatula* Gertsch and Wallace is similar in coloration and pattern to *P. atlantica* except the pedipalps in the male differ. The abdomen is a dull yellow in the middle and darker on the sides. *P. delicatula* is not often seen in cotton fields. The length of the female ranges from 5 to 6.5 mm; length of the male is from 4.5 to 5.1 mm. This species is widespread in Texas from May through September and is at least part aquatic or semi-aquatic. It consumes mosquito larvae in still-water conditions (Breene et al. 1988a), as do other *Pardosa* spp. (Greenstone 1978, 1979a, b, 1980).

*Pardosa milvina* (Hentz) has colors and patterns similar to the species already mentioned, which underscores the difficulty in distinguishing the species of this genus. In *P. milvina*, however, the dorsal stripes on the carapace undulate more than in the other species. The length of the female ranges from 5.1 to 6.4 mm; length of the male is from 4.3 to 5.0 mm. The species is found in the eastern third of Texas from May through September. At least two eggsacs per season have been recorded. The eggsacs are about 3.5 to 4.7 mm in diameter and contain about 32 to 93 eggs. The species normally stays near the ground during the day, but relatively large numbers have been observed foraging on cotton plants at night. Because most cotton field sampling is completed during the daylight hours, the numbers of this species relative to others is unknown. Research conducted on cotton fleahopper predation ecology linked *P. milvina* to fleahopper consumption (Breene et al. 1989a, b). Hayes and Lockley (1990) present notes on nocturnal predation ecology, and Nyffeler et al. (1990a) listed the species as a predator of insect eggs.

*Pardosa pauxilla* Montgomery has a carapace similar to *P. delicatula*. Length of the female ranges from 4.5 to 5 mm; length of the male is from 4 to 4.5 mm. The species is widespread in Texas from May through September but is rarely noticed on cotton during the day. The dirty gray eggsac may contain about 62 eggs, and as do most wolf spiders, the female carries the eggsac attached to her spinnerets until the spiderlings emerge. Upon leaving the eggsac, the spiderlings are carried on the mother's back for a time before dispersing. Dietary notes of the species on peanuts can be found in Agnew and Smith (1989) and on guar in Rogers and Horner (1977).

*Pardosa sternalis* (Thorell) is not often observed in cotton ecosystems, possibly because of the ground-dwelling characteristics of this species. This wolf spider species is similar to *P. milvina*, differing mainly in the specific pattern of the yellow spots on the dorsal abdomen. The length of the female ranges from 6 to 7 mm; length of the male is from 5 to 6 mm. The species is known to occur in the western third of Texas.

The wolf spider genus *Pirata* can be distinguished by the darkened Y-shaped pattern (like a tuning fork) on a yellow band that runs dorsally on the cephalothorax from the eye region to the posterior. This genus is normally associated with aquatic or semi-aquatic freshwater ecosystems and was probably captured in cotton fields near ponds or streams or perhaps during migration. Many if not all members of the genus can run across the water's surface and temporarily duck underwater to capture prey or to hide when startled. At least some of the species can prey upon mosquito larvae beneath the surface of still water (Breene et al. 1988b).

*Pirata davisi* Wallace and Exline is found in the eastern half of Texas.

*Pirata seminola* Gertsch and Wallace is found in central, eastern, and northern Texas from May through September. The male is 2.7 to 4.3 mm long, and the female is 3.1 mm in length. Neither species of *Pirata* is common in Texas cotton ecosystems.

*Rabidosa rabida* (Walckenaer) is perhaps the most common and best known of the wolf spiders in the United States. The dorsal abdomen has a fairly distinct pattern in the form of lighter longitudinal stripes with a series of light chevrons within a darker background. Eggsacs are from 7 to 10 mm in diameter and contain from 168 to 365 eggs. The length of the female ranges from 16 to 21 mm; length of the male is about 12 mm. They have been recorded in Texas from May through September.

*Schizocosa avida* (Walckenaer) is a brown and gray spider with a darkened area over the cardiac region on the dorsal abdomen. The length of the female ranges from 6.6 to 14.7 mm; length of the male ranges from 6.3 to 9.8 mm. The species can sporadically be numerous on cotton and in other habitats. It is widespread in Texas and is found from May through September.

*Varacosa acompa* (Chamberlin) has a dark brown carapace with light bands in the middle and on the sides; the abdomen is a darker color. The length of the female is about 5 mm; length of the male is about 6.1 mm. The species inhabits the eastern half of Texas.

When more is known about the predation ecology of wolf spiders, the species may be found to be important in Texas cotton ecosystems. Further information is contained in Yeargan (1975), Nyffeler and Benz (1988a), and Hayes and Lockley (1990). Descriptions are in Gertsch (1934), Gertsch and Wallace (1935), Kaston (1948, 1978), Vogel (1970b), Wallace and Exline (1978), and Dondale and Redner (1978a, 1983, 1984).

## Mimetidae: Pirate Spiders

Although the yellow to whitish pirate spiders have been occasionally reported to capture insects, their preferred prey is other spiders (Bristowe 1958, Nyffeler and Benz 1981a).

*Ero* sp. is uncommon in Texas cotton. It is pale gray to light yellow and has a pair of conical tubercles on the highest part of the abdomen. The length of the female ranges from 2.7 to 3.4 mm; length of the male ranges from 2.3 to 2.6 mm. *Ero* sp. is found near the ground and has an eggsac that is pale brown, spherical, and about 3.5 mm in diameter.

Though not especially common, three species occur in cotton fields from June to August. The first is *Mimetus hesperus* Chamberlin, which is usually found on the underside of the leaf in the upper quadrant of the cotton plant. The length of the female ranges from 4.0 to 6.3 mm; length of the male ranges from 3.5 to 4.5 mm. *Mimetus hesperus* has been reported preying upon black widow spiders, the small theridiid *Theridion* sp., and *Dictyna* sp. (Agnew and Smith 1989).

*Mimetus notius* Chamberlin is also largely found on the underside of leaves in the upper half of the cotton plants. The overall background is yellow. The abdominal folium is a mass of curved, wavy, or zigzag black lines encompassing red markings. The cephalothorax has W-shaped black markings. The length of the female is about 5 mm; length of the male is about 4 mm.

The carapace of *Mimetus puritanus* Chamberlin has dark, double Y-shaped lines; the branched part of the "Y" is in the eye region. The border along the folium on the abdomen has a serrated black line and two comma-like pale or white marks between the "shoulders." The length of the female ranges from 5.0 to 5.6 mm; length of the male ranges from 4.0 to 4.5 mm. Feeding records for *M. notius* and *M. puritanus* have been noted by Archer (1941).

A revision of the family was last completed by Chamberlin (1923).

## Miturgidae

Previously placed in the genus *Syrisca* of the family Clubionidae, *Teminius affinis* Banks can be identified by the long posterior lateral spinnerets that are equipped with two subequal segments, the two tarsal claws, and by the large body size (as long as 15 mm). The carapace is dull yellow and the abdomen is gray (as seen from above). It has been collected from July to August in the eastern half of Texas. Platnick and Shadab (1989) revised the genus.

## Mysmenidae

The mysmenids may be closely related to the theridiids. The family is only rarely observed in the eastern half of Texas, probably because of its small size (often < 1 mm). The single species occasionally found in Texas cotton fields is *Calodipoena incredula* Gertsch and Davis. The length of the female ranges from 0.7 to 1.0 mm; length of male is 0.5 to 0.8 mm. The species exhibits a brown carapace and a dusky to blackish abdomen accommodating 8 to 10 white spots. A revision was published by Gertsch (1960).

## Nesticidae: Cave Spiders

When in cotton fields, cave spiders typically build their loosely meshed webs in protected crevices. Cave spiders hang upside down in their webs and construct eggsacs (as many as 96 eggs), which they attach to their spinnerets or keep closely by them in the web. The sacs are spherical, 4 mm in diameter, and thinly covered with whitish transparent silk. The single widespread species found in Texas cotton fields is *Eidmannella pallida* (Emerton), a small spider with orange legs and carapace and a grayish abdomen. The length of the female ranges from 2.2 to 4.0 mm; length of the male is from 2.2 to 2.8 mm. Because of their preferred habitat location, these spiders may be involved in predation upon the ground-litter-inhabiting, overwintering boll weevils, but no evidence of this exists. Cave spiders are related to theridiids. Gertsch (1984) published a revision of this family.

## Oxyopidae: Lynx Spiders

The lynx spiders are probably the most economically important family of spiders in cotton ecosystems. Most live on tall grass and native vegetation that may act as a predator reservoir for continuous recolonization of cotton fields each spring (Nyffeler et al. 1992a).

*Oxyopes apollo* Brady is generally smaller than the striped lynx spider. The length of the female ranges from 4.2 to 6.7 mm; length of the male is from 3.4 to 4.4 mm. The dorsal abdomen is brown with a lighter central stripe. This species of *Oxyopes* is not often seen on Texas cotton but is widespread from July through September.

The striped lynx spider, *Oxyopes salticus* Hentz, may be the single most important spider species on cotton in most regions and possibly in most agricultural ecosystems in the United States east of the Rocky Mountains. The thin, spindly legs are armed with many long spines that have a velcro-like appearance on one half when viewed under a scanning electron microscope. The dorsal cephalothorax has a yellowish base with four gray bands running lengthwise from the eyes to the pedicel. A broad black band appears on the ventral abdomen, and the dorsal side is distinctly patterned in the female. The adult male abdomen is covered with scales, giving it a bronze, mirror-like appearance. Puffy black triangular pedipalps are very conspicuous in the front of the male. Length of the female ranges from 5.7 to 6.7 mm; length of the male is from 4 to 4.5 mm. The female attaches the disk-like eggsac to a substrate such as a leaf and guards it until the young emerge. This species, found throughout the state, is most abundant in the eastern half of Texas and appears throughout the cotton season. The biology of *O. salticus* has been described by Whitcomb and Eason (1967). This species is readily captured by sweep nets, but eggsacs are uncommon in collections because they are not readily dislodged. *O. salticus* is commonly the most abundant species, approaching 7 per meter of row in cotton (Nyffeler et al. 1987a) and many other crops. It readily disperses into other habitats by ballooning (Dean and Sterling 1990).

The striped lynx spider is a key predator of the cotton fleahopper (Dean et al. 1987, Breene 1988, Breene and Sterling 1988, Breene et al. 1988a, 1989a, b, 1990). Using radio-labeling techniques, Breene et al. (1989a) found that 31% of all striped lynx spiders captured in a cotton field were radioactive from consuming immature radioactive fleahoppers. Striped lynx spiders also consume bollworm/tobacco budworm eggs and larvae and other prey (Young and Lockley 1985, 1986, Young and Edwards 1990, Nyffeler et al. 1987a, 1990a, 1992b, c).

The green lynx spider, *Peucetia viridans* (Hentz), has a predominantly bright green body with paler green legs, which are long, spindly, and equipped with black spines and spots. The dorsal cephalothorax has variable red patterns near the eyes. The length of the female ranges from 14 to 16 mm; length of the male is from 12 to 13 mm.

The green lynx spider can be common on cotton, where it may be a significant predator of cotton fleahoppers and Lepidoptera larvae and eggs (Breene et al. 1989a, Nyffeler et al. 1990a). Usually perched near the apex of the plant, adults are often observed feeding upon a wide range of prey (Turner 1979, Randall 1982, Nyffeler et al. 1987c), which may often include beneficial insects such as honey bees and bumble bees (Nyffeler et al. 1992c). At times, the green lynx spider appears so fond of honey bees and other beneficial insects that at least one author (Randall 1982) questioned whether the species could be considered beneficial. Sphecid and vespid wasps, cotton leafworm larvae, bollworm adults, and boll weevil adults are also included on the prey list (Whitcomb et al. 1963, Nyffeler et al. 1992c).

In the fall, adults mate while suspended in space on a dragline (Exline and Whitcomb 1965, Whitcomb and Eason 1965, Bruce and Carico 1988) before building their straw-colored eggsac (1.2 to 2.5 cm in diameter, containing from 129 to 602 eggs) and subsequently guarding it (Whitcomb 1962, Whitcomb et al. 1966). Spiderlings are orange immediately after emergence but soon turn the familiar green. Females also have been known to build foliage shelters for the eggsac (Willey and Adler 1989) and have been observed spitting venom from their fangs when disturbed while guarding the eggsac (Fink 1984). Green lynx spiders are found throughout Texas mainly from July through October. The later instars are found in cotton. More information on green lynx spiders can be found in Kaston (1972), Weems and Whitcomb (1977), Randall (1977, 1978), Turner (1979), Killebrew (1982), Killebrew and Ford (1985), and Fink (1986).

Brady (1964) published a revision of this family.

## Philodromidae: Running Crab Spiders

The running crab spiders are similar to the Thomisidae; however, none of the running crab spiders have been found in large numbers on Texas cotton. All four pairs of legs are somewhat similar in length, except the second pair is longer than the rest in some species.

*Ebo punctatus* Sauer and Platnick can be separated without difficulty from the other species because leg II is much longer than the remaining legs. The overall color is pale yellow with scattered, dark spots on the carapace. Length of the female ranges from 3.1 to 4.6 mm; length of the male is from 2.1 to 2.2 mm. The species occurs in the northern two-thirds of Texas.

*Philodromus pratariae* (Scheffer) has a yellowish carapace with a pair of broad, indistinct orange-yellow longitudinal bands laterally. The abdomen is reddish brown, slender, and truncate toward the anterior. Length of the female ranges from 4.6 to 5.8 mm; length of the male is from 4.2 to 5 mm. The species occurs in the eastern half of Texas.

*Thanatus formicinus* (Clerck) is generally brown to gray with a pale longitudinal pattern on the carapace. The abdomen shows a dark diamond-like shape. Eggsacs are cream colored and shaped like a biconvex lens. Fitch (1963) noted that this spider was collected only from grasslands. Length of the female ranges from 6 to 8 mm; length of the male is from 5 to 6 mm. The species has not been collected in the more western regions of Texas.

*Tibellus duttoni* (Hentz) does not resemble a typical crab spider but instead is highly elongate and spindly, with long, thin legs usually stretched out fore and aft while at rest. The body is gray or yellowish with a darker lengthwise pattern. Four spots adorn the abdomen. Members of this spider species were found to be predators of cotton fleahoppers (Breene et al. 1989b). Length of the female is about 8 mm; length of the male is about 6 mm. The species occurs in the eastern half of Texas.

Revisions in this family include those by Dondale and Redner (1969, 1978b) and Sauer and Platnick (1972).

## Pisauridae: Nursery-Web Spiders

Nursery-web, or fishing, spiders are not common on Texas cotton. They primarily prefer aquatic habitats. Many have adaptations that allow them to skate on the surface of the water and dive beneath it to search for prey or hide from enemies.

Pisaurids, especially immatures of *Dolomedes triton* (Walckenaer), consume mosquito larvae and other aquatic prey (Breene et al. 1988b). Pisaurids are occasionally found on Texas cotton. *D. triton* are large: length of the female ranges from 17 to 20 mm; length of the male ranges from 9 to 13 mm. The carapace is gray to brown with light submarginal areas and light spots on a brown abdomen. Some of the larger species of *Dolomedes* are considered minor nuisance pests at fisheries because the adults capture small fish. The reproductive cycle of the nursery-web spiders takes them away from the water, which may account for their occasional presence on cotton. Their potential as a cotton insect pest predator is not known.

Carico (1973) did a revision of the genus *Dolomedes*.

## Salticidae: Jumping Spiders

Jumping spiders are easily recognized by the organization of their eyes into three rows, although exceptions exist. The enlarged anterior median eyes have highly developed visual capabilities. Mobile prey are detected visually, stalked, and attacked (Forster 1982). With their pedipalps, many species also constantly tap the terrain over which they travel. These pedipalps probably contain tactile chemoreceptors sensitive to prey semiochemicals (Nyffeler et al. 1990a). When the spider perceives an inanimate object such as an insect egg as a potential energy source, it may consume it (Nyffeler et al. 1990a). The females place the eggsacs inside silken reproductive nests, where the females remain until the spiderlings can disperse.

*Admestina tibialis* (C. L. Koch) has a dark carapace and an abdomen with a dark line down the middle. The sides of the abdomen are covered with round, whitish scales. Eggsacs are whitish, 2.4 mm in diameter, and typically contain about four eggs. Length of the female ranges from 3.5 to 4 mm; length of the male is from 2.5 to 3.5 mm. The species occurs in eastern and northern Texas.

*Agassa cyanea* (Hentz) is described by Kaston (1978) as having its entire body covered by iridescent scales, giving it a green to purplish or occasionally coppery-brown appearance. Length of the female ranges from 3.3 to 4.6 mm; length of the male is from 3.1 to 4 mm. The species occurs in the northern two-thirds of Texas in July and September.

The males of *Eris militaris* (Hentz) (formerly *Eris marginata* [Walckenaer]) have moderately fringed first legs and large chelicerae that extend forward from the body. Length of the female ranges from 5 to 8.5 mm; length of the male is from 3.9 to 8 mm. The species occurs in the eastern half of Texas.

*Habronattus coecatus* (Hentz) can sporadically become fairly common in cotton fields. The species has been noted as a predator of cotton fleahoppers (Dean et al. 1987, Breene et al. 1989b). The male has reddish hairs on its face and a medium-sized white abdominal spot with two smaller white spots further toward its posterior. The abdomen of the female is gray to light brown. Length of the female is about 5.5 mm; length of the male is slightly smaller. The species occurs in the eastern two-thirds of Texas from May through August.

Species of the genus *Hentzia* have spatulate hairs immediately lateral to the anterior eye row. Their bodies are somewhat dorso-ventrally flattened. Males of *Hentzia mitrata* (Hentz) typically do not have elongated chelicerae and lack pigmentation on the first legs (Richman 1989). Legs are white to pale yellow, and the male has a carapace similar to *H. palmarum* (Hentz), although the dorsal abdomen is yellow or orange. The abdomen of the female is yellowish with a central row of dark brown triangular spots. Length of the female ranges from 2.9 to 4.5 mm; length of the male is from 3.5 to 4.1 mm. The species occurs in northern and eastern Texas.

*Hentzia palmarum* has been noted as a predator of fleahoppers on cotton (Breene et al. 1989b). The chelicerae of the males are highly elongate, more so even than that of *Eris*, a salticid genus with which they can be confused. Legs are white to yellowish except for the dark brown first pair of legs on the male. The male has two white stripes running from the head region to the spinnerets on either side dorsally. Females are covered with gray scales and typically have a chevron pattern on the dorsal abdomen. Length of the female ranges from 4.7 to 6.1 mm; length of the male is from 4.0 to 5.3 mm. The species has been collected from the eastern two-thirds of Texas from June through September.

*Lyssomanes viridis* (Walckenaer) was once placed in its own family (Lyssomanidae) but has been returned to the Salticidae. Its eyes are unusual in that they are arranged in four rows. This species is light green, and the second, third, and fourth rows of eyes are encircled with a black area. Length of the female ranges from 7 to 8 mm; length of the male is from 5 to 6 mm. Occurring in eastern Texas, the species is not common on cotton.

*Marpissa formosa* (Banks) has a dark brown carapace, margined with a narrow black band. The front legs are brown, and the remaining legs are straw yellow. The dorsal abdomen of the female has a pale basal band and a median chalky band that is indented in its posterior half. The male abdomen is dark brown to black with a basal band of white scales and three pairs of pale spots overlain by a pair of broken bands of white scales. Length of the female ranges from 7 to 9 mm; length of the male is from 6.5 to 8.1 mm. The species occurs in the eastern half of Texas.

*Marpissa lineata* (C. L. Koch) is less narrow, not as elongate, and smaller than *M. pikei*. Legs of the male are yellow except for the distinct darkened tibia of leg I; the female has brown legs. The dorsal abdomen of both sexes has two pale, longitudinal stripes on a dark brown background. Length of the female ranges from 4 to 5.3 mm; length of the male is from 3 to 4 mm. The species is found in the eastern half of Texas.

*Marpissa pikei* (G. and E. Peckham) is a narrow, elongate salticid species. The female is light gray or tan with indistinct brown dorsal patterns, and the male has a more distinct row of black spots. Length of the female ranges from 6.5 to 9.5 mm; length of the male is from 6 to 8.2 mm. It is found in the eastern half of Texas.

*Metaphidippus chera* (Chamberlin) (=*Dendryphantes chera* Chamberlin, 1924, NEW SYNONYMY [our thanks to Wayne Maddison for giving us permission to use this synonymy before the completion of his revision of the genus]) has white bands adorning the sides of the dark brown cephalothorax. The dorsal abdomen is brown with five pairs of black spots. Length of the female ranges from 4.2 to 4.8 mm; length of the male is from 3.3 to 4.0 mm.

*Metaphidippus exiguus* (Banks) has yellow chelicerae with a distinct black marking that separates it from similar species (Kaston 1978). Length of the female ranges from 4.0 to 5.6 mm; length of the male is from 3.3 to 5.1 mm. The species occurs in eastern Texas.

*Metaphidippus galathea* (Walckenaer) was found to be the second most numerous salticid predator of the cotton fleahopper behind *P. audax* during 1986-1987 (Breene et al. 1989a). It also feeds on other small insects and spiders (Horner 1972, Wheeler 1973, Dean et al. 1987). The species may be quite common at times on cotton and other crops and in pastures and uncultivated areas. Legs of both sexes are darkly ringed, and the male has broad white bands stretching from the eyes to the posterior of the dark brown abdomen on either side. Females are gray and white and have a chevron-like abdominal pattern. An average of 158 eggs per eggsac was found by Horner and Starks (1972). Length of the female ranges from 3.6 to 5.4 mm; length of the male is from 2.7 to 4.4 mm. The species has been collected from May through September throughout Texas.

*Phidippus audax* (Hentz) is a large, black and hairy spider, typically with a large white spot centered on the dorsal abdomen and two smaller posterior spots; however, the large spot may be red, yellow, or orange depending on local population variation and maturity. The abdominal spot is typically white in adults. Eggsacs are lenticular, about 9 mm in diameter, and contain from 67 to 218 eggs. Length of the female ranges from 8 to 15 mm; length of the male is from 6 to 13 mm. The species is found largely in the eastern half of Texas from May through September.

*Phidippus audax* is the most commonly seen salticid on Texas cotton and on many if not all other crops as well (Young and Edwards 1990). On cotton, *P. audax* was the second most important spider species found preying upon fleahoppers (Breene et al. 1989a, b). In tests involving functional responses, *P. audax* had the highest efficacy of fleahopper consumption of the three spider species examined (Breene et al. 1990). *P. audax* has also been recorded feeding on boll weevil adults and adults and larvae of the bollworm, pink bollworm, tobacco budworm, cotton leafworm, and tarnished plant bug (Kagan 1943, Clark and Glick 1961, Whitcomb et al. 1963, Whitcomb and Bell 1964, Bailey and Chada 1968).

Muniappan and Chada (1970b) found *P. audax* capable of controlling greenbug numbers in a small laboratory test conducted on barley plants. Although *P. audax* can assist other predators and parasitoids in field greenbug control, it probably cannot control an infestation because its field numbers are usually low relative to the pest and because it lacks a numerical response probably required of a biological control agent when dealing with SE pests of high reproductive potential.

*Phidippus cardinalis* (Hentz) is distinguished from other *Phidippus* by the bright red cephalothorax and abdomen. Length of female is about 9 mm; length of the male is about 8 mm. The species has been collected from northern and eastern Texas.

Males of *Phidippus clarus* Keyserling have a black carapace and an abdominal pattern with reddish lateral markings that are notched on the outer edges. Females are generally brown to orange yellow. Both have white anterior border stripes (basal bands) on the abdomen above the pedicel. Eggsacs are 8 mm in diameter and contain about 75 eggs. Length of the female ranges from 8 to 10 mm; length of the male is from 5 to 7 mm. The species has been collected from northern and eastern Texas.

The reddish-brown carapace of *Phidippus texanus* Banks is sheathed in gray hairs. The dorsal abdomen of this uncommon cotton visitor displays a distinct, white longitudinal pattern in females and is densely covered with red hairs in males. Eggsacs contain about 150 eggs. Length of the female ranges from 12 to 13 mm; length of the male is from 8 to 9 mm. The species has been collected from the northern half of Texas.

Members of the genus *Phidippus* are aggressive predators and have been observed pursuing huge prey relative to their size (Gardner 1965). Additional predation literature may be found in Freed (1984), Roach (1987), and Young (1989a, b).

*Sarinda hentzi* (Banks) is not commonly seen on Texas cotton. Brownish orange is the overall background color of this small, ant-mimicking spider species. The abdomen is constricted immediately anterior to the mid line and marked with a white band. Length of both the female and the male ranges from 5 to 7 mm. The species occurs in the eastern half of Texas from June through August.

Like *Agassa cyanea, Sassacus papenhoei* (G. and E. Peckham) is covered by iridescent scales. Its first legs are noticeably the largest. It is distinguished by a white or yellow stripe running along the side margins of the body. Length of the female ranges from 4.4 to 5.5 mm; length of the male is from 2.8 to 4.7 mm. The species has been collected from northern and western Texas from July through September.

*Sitticus dorsatus* (Banks) has a dark reddish-brown carapace and a black spot around the eye area. The carapace margins are covered with white hairs. Its abdomen is reddish brown with white chevrons, and its sides have four white spots nearly contiguous with the chevrons. Length of the female is about 3 mm; length of the male is about 2.3 mm. The species has been collected from the eastern half of Texas.

*Thiodina puerpera* (Hentz) females are yellowish-tan, and males have a dark red brown carapace, a middle white band, and an abdomen covered with brown hairs. The male also has one short white stripe under the posterior lateral eyes. Length of the female ranges from 7 to 10 mm; length of the male is from 5 to 6 mm. The species is found in the eastern half of Texas.

*Thiodina sylvana* (Hentz) is similar to the preceding species, but it has two white stripes running parallel from the posterior of the carapace to the spinnerets. The male has three short white stripes under the posterior lateral eyes, and the abdomen may appear to be dark green. Length of the female ranges from 8 to 10 mm;

length of the male is from 7 to 9 mm. The species occurs in the eastern half of Texas.

Members of the genus *Zygoballus* have been noted in moderately high field numbers on cotton and on grasses in some years, yet in other years, it is nearly absent. The genus can be distinguished from others by the tallest part of the cephalothorax being immediately behind the last pair of eyes, then abruptly sloping to the pedicel.

*Zygoballus nervosus* (G. and E. Peckham) males have metallic abdomens with white markings, whereas the females appear similar to *Z. rufipes*. Length of the female ranges from 3 to 4 mm; length of the male is from 3.3 to 4.5 mm. The species has been collected from eastern and central Texas.

*Zygoballus rufipes* G. and E. Peckham has been recorded preying upon cotton fleahoppers (Dean et al. 1987). The male abdomen is bronze-brown with white markings. Females have whitish scales that form patterns similar to those of the male but less distinct. Length of the female ranges from 4.3 to 6 mm; length of the male is from 3 to 4 mm. The species occurs in eastern Texas.

Further information on salticids can be found in Peckham and Peckham (1909), Gertsch (1934), Gertsch and Mulaik (1936), Kaston (1948, 1973, 1978), Barnes (1958), Griswold (1987), and Richman (1989). Richman and Cutler (1978) present a checklist and key to the genera of American salticids. Roth (1985) updated the key.

## Tetragnathidae: Long-Jawed Orb Weavers

The Tetragnathidae have been removed from, and then rejoined to, the orb weaver family Araneidae more than once in the past. Although much of the literature places them near water in habitat preference, they are nearly ubiquitous in certain areas. Members of this family spin an orb web that may often be closer to horizontal than vertical.

The first species, *Glenognatha foxi* (McCook), is an uncommon visitor to cotton. The carapace is orange and the top of the abdomen is orange white with paired silver spots on posterior portions. The species is widespread in Texas and readily balloons (Dean and Sterling 1990). The length of the male ranges from 1.5 to 2.2 mm, the female being slightly larger. The spider makes a horizontal web about 11 cm in diameter about 5 cm above the ground. Grass often grows through the silken lines of the web.

At times, *Tetragnatha laboriosa* Hentz is the most abundant spider species on cotton, especially in western states. The reproductive capabilities of this species are remarkable, perhaps outdone only by their inherent capacity to disperse aerially. The species was found to be a predator of immature cotton fleahoppers on woolly croton (Breene et al. 1988a) but not on cotton, although it likely preys upon fleahopper adults caught in its web. This spider was observed capturing small insects of the orders Diptera, Hymenoptera, and Homoptera in cotton in Arkansas and Texas (Whitcomb et al. 1963, Nyffeler et al. 1989). This spider often builds its web on the upper half of the cotton plant (Dean et al. 1982).

The legs and carapace of *T. laboriosa* are yellowish, and the abdomen is elongate and silvery. The length of the female ranges from 5.2 to 9 mm; length of the male is from 3.8 to 7.4 mm. The species is ubiquitous in the United States and Canada to Alaska (Kaston 1978) and found in cotton from May to September. Forty to 76 eggs are deposited in the eggsacs. More information on *T. laboriosa* can be found in LeSar and Unzicker (1978) and Culin and Yeargan (1982). Revisions were completed by Levi (1980, 1981).

## Theridiidae: Comb-Footed Spiders

The name "comb-footed" originates from the presence of a row of 6 to 10 comb-like serrated bristles on the ventral surface on the tarsi of leg IV, which are used to fling and manipulate silk on the prey. Members of the Theridiidae constitute an important part of the predator assemblages among the Texas cotton spiders, sometimes becoming quite numerous. Theridiid species utilize areas throughout the cotton plant structure for web building, and each web is equipped with numerous tunnel-like areas and passageways within its asymmetrical framework. The webs have been found from the base of the plant to the highest apical terminals and all areas between.

The cephalothorax and legs of *Achaearanea globosa* (Hentz) are orange, and the dorsum of the abdomen from the midpoint to the spinnerets is whitish with black markings. The length of the female ranges from 1.0 to 2.2 mm; length of the male is from 1.1 to 1.7 mm. The eggsacs are spindle shaped, brown, and hung within the irregular web. Kaston (1948) reported the species from leaf litter, along the edges of fallen logs, and in holes in tree stumps. Found in the eastern half of Texas, the species is not common in Texas cotton fields.

Although not collected on cotton in Texas, a related species, *Achaearanea tepidariorum* (C. L. Koch), also known as the common house spider, is probably the spider most often observed by humans in the United States and is almost exclusively found in and around houses, outbuildings, and other protected places such as cliff faces (Riechert and Cady 1983). The common house spider is not poisonous, but has roughly the same shape as the black widow spider and is often mistaken for it, even though adults are only about half the size of adult black widows and are mottled brown or gray. Abandoned webs inside human habitations (cob-webs) are often made by this species.

Members of the genus *Achaearanea* often capture various ants and beetles (Nyffeler and Benz 1981a, 1988c). *A. tepidariorum* was also observed trapping red imported fire ants (Nyffeler et al. 1988b), a trait probably quite common for theridiids and other web weavers on cotton (Breene 1991b).

Spiders are typically highly cannibalistic, solitary animals; however many notable exceptions exist. One of these is a social species of theridiid, *Anelosimus studiosus* (Hentz), found occasionally on cotton in the eastern half of Texas from April to October. They typically occupy forested regions on tree limbs but also appear on low vegetation.

Near Lake Somerville, Texas, colonies can be consistently found inhabiting branches of live oak trees along the lakeshore. The web is a platform sheet with irregular capture threads spun above it into which potential prey fly and fall to be captured. Muma (1975) found the carcasses of numerous adult midges in the webs of *A. studiosus* and concluded that these insects probably form a large part of its diet, at least in areas where the freshwater conditions are conducive to midge development.

An adult female typically initiates colonies. She begins a nest web alone and produces eggsacs containing approximately 30 to 50 eggs, which she will guard (Buskirk 1981). After spiderling emergence, the mother feeds the spiderlings with her regurgitated food. Later in their development, she will supply the spiderlings the prey she has captured. As the spiderlings mature, they begin to assist the mother in securing prey. The length of the female ranges from 3.2 to 4.7 mm; length of the male ranges from 2.1 to 3.3 mm. The carapace and legs are orange yellow, and a dark median band bordered with white appears on the abdomen. *Anelosimus studiosus*, requiring a less-ephemeral ecosystem for successful survival, is only rarely found on cotton. More information on the biology of *A. studiosus* is in Brach (1977).

Although members of the species *Argyrodes trigonum* (Hentz), found from July to September, can build their own webs, they are more commonly observed in the webs of other spiders in eastern Texas. They have been noted occupying the periphery of webs of giant orb-weaving spiders of the genus *Araneus*, whose webs may have foundation lines stretching 10 m or more between trees in forested areas. When in the webs of other spider species, they are considered kleptoparasitic (stealing prey caught on the web of the orb weaver or taking prey already captured and wrapped by the host spider). Occasionally *A. trigonum* may feed on the web owner. Nyffeler and Benz (1980b) discussed the various aspects of kleptoparasitism in spider webs.

*A. trigonum* are most commonly reddish brown with a triangular abdomen. The length of the female ranges from 3.7 to 4.2 mm; length of the male ranges from 2.4 to 3.3 mm. The eggsacs (6 mm long with 15 to 49 eggs) are distinctively urn shaped and suspended from the web by a silk thread. The color of the eggsac changes from white when new to brown with age. This species is not common on cotton and is probably only an occasional visitor upon the webs of endemic orb weavers.

Individuals of a similar species, the silver colored *Argyrodes elevatus* Taczanowski, were observed in the orb-webs of *Argiope aurantia* (Nyffeler et al. 1987b).

The comb-footed spider species *Coleosoma acutiventer* (Keyserling) (the female is about 1.7 mm long; length of the male is about 2.1 mm) is a rare visitor to eastern and southern Texas cotton ecosystems. The carapace is gray brown; the abdomen is cylindrical and dark gray to black and constricted in the middle by a narrow white band. Its legs are long, slender, and pale (Bryant 1944). Little is known about the biology and behavior of this species. Nyffeler et al. 1990a reported that *C. acutiventer* is a predator on the eggs of the sugarcane borer, *Diatraea saccharalis* (Fab.), a pest of sugarcane.

Members of the genus *Euryopis* occur throughout Texas but are uncommon in cotton fields. They are reportedly found under leaves or moss at ground level and under stones and bark. Fitch (1963) states that members of this genus do not spin webs to capture prey, are crab-like in appearance, and feed upon ants. The body length of both sexes ranges from 3 to 4 mm, and the abdomen is elongate and subtriangular, somewhat pointed posteriorly.

The southern black widow spider, *Latrodectus mactans* (Fab.), can be fairly common on cotton in the eastern half of Texas (Nyffeler et al. 1988b). The eggsacs are round, grayish or dirty white, and from 10 to 12 mm in length with a pointed apical tip. They contain from 25 to 250 or more eggs per eggsac, according to Deevey (1949) and Williams et al. (1986a), although others have observed as many as 400 eggs, suggesting that the number of eggs may depend upon the nutritional status of the female during egg deposition.

The black widow eggs hatch into a postembryo stage and molt once again within the eggsac into first instar spiderlings (sensu Downes 1987). The first instar spiderlings typically emerge about 4 weeks after eggsac production. First instar spiderlings are highly adept at ballooning and are small enough to penetrate standard window screens but are harmless to humans at this stage. Newly emerged spiderlings are not cannibalistic until 10 days to 2 weeks after emergence, whereupon they become, seemingly overnight, highly cannibalistic. The onset of cannibalism could simply indicate when their supply of yolk stored in their bodies is depleted, or it may be due to the presence or absence of some semiochemical controlling factor.

The black widow has been collected in cotton from June to September; however, in buildings, adults of both sexes have been found throughout all months. The length of the female ranges from 8 to 10 mm; length of the male ranges from 3 to 4 mm, but sizes within different geographical populations can vary widely. The abdomen of immatures is gray with curved white stripes. The males retain these markings, whereas the females are typically black dorsally but some have red markings. The most prominent marking is the red hourglass on the venter.

In Texas west of Austin, the species is probably replaced by its western counterpart, *Latrodectus hesperus* Chamberlin and Ivie. In southwestern Texas through the Lower Rio Grande Valley and adjoining parts of Mexico, a variant or sub-population of *L. hesperus* has been found in which the adults retain their brilliant juvenile colors. Further west, the coloration of the species appears to grade back to black. *L. hesperus* has been observed feeding on ants (MacKay 1982).

The irregular web of the adult or sub-adult female *Latrodectus mactans* may occasionally be stretched across the cotton plants between rows and is quite strong, having a tensile strength similar to that of steel. The spider builds a retreat, typically a 2-mm to 8-cm circular or semicircular silken tent under a leaf or in debris at the base of the plant or in cracks in the ground near the plant. Here the spider spends most of her time, venturing out onto her web for web maintenance or when attracted by prey vibrations. In southern Texas sugarcane, the females also prefer the base of the plant, usually making their retreat in the center of a clump of plants (unpublished data).

In eastern Texas cotton fields, 75% of the observed prey of *L. mactans* were red imported fire ants (Nyffeler et al. 1988b); however, because the cotton field was under nearly complete natural biological control by the ants, *L. mactans* in cotton fields without ants would likely have a different prey spectrum. Boll weevils from both field and laboratory sources (Whitcomb et al. 1963), grasshoppers, June beetles, and scorpions are also included on the large list of prey known for *L. mactans*.

Contrary to common belief and an overwhelming quantity of erroneous accounts in the popular literature (including current dictionaries), the female does not consume the male in most situations (Breene and Sweet 1985, Williams et al. 1986a), except when held together in cages from which the male cannot depart. Of the more than 20 *Latrodectus* species worldwide, the male of only one species occurring in New Zealand is currently known to be consumed by the female (Forster 1992). This behavior has not been reported in *Latrodectus* spp. of the Americas.

*Latrodectus* spp. are commonly among the spider species hunted by mud dauber wasps (Hymenoptera: Sphecidae), which capture and paralyze the spiders with their sting. The wasp lays an egg at the blind end of the dauber cell, which is then provisioned with paralyzed spiders. The mud dauber egg hatches, and the young larva uses the spiders as its food source until it finally pupates and emerges from the cell (Dean et al. 1988).

*Steatoda triangulosa* (Walckenaer) has been found under stones, bridges, culverts, and in buildings, where it was feeding on ants (Fitch 1963, Kaston 1978). In Texas, this spider was reported to feed on the red imported fire ant (MacKay and Vinson 1989). The length of the female ranges from 3.6 to 5.9 mm; length of the male ranges from 3.5 to 4.7 mm. The eggsacs (5 mm in diameter) are made of loosely woven white silk, making the individual eggs (about 30) visible. The cephalothorax is brownish orange, with yellow legs grading darker toward each segment's distal end. The abdomen is yellow with brown to purplish markings. Males of this genus produce sounds during sexual and agonistic displays by scraping together the elements of a stridulatory organ located on the posterior cephalothorax and anterior abdomen (Lee et al. 1986, Nyffeler et al. 1986b). This species occupies the eastern half of Texas, where it is uncommon in cotton fields but is common in houses.

In buildings, *Steatoda* spp. individuals have been observed killing detrimental insects including house flies, roaming larvae and adult mealworms (*Tenebrio* sp.), and adults of various meal-infesting Lepidoptera (Nyffeler et al. 1986b, unpubl. data).

The genus *Theridion* contains many species, most of which are small bodied and make a tiny web in a variety of places throughout the cotton plant, although mostly in the upper half. The most commonly observed species in cotton ecosystems throughout Texas is *T. australe* Banks from May to September. The length of the female ranges from 2.0 to 3.0 mm; length of the male ranges from 1.9 to 2.3 mm. The carapace is yellow to orange, except the ocular area, which is blackened. The abdomen is orange white with two black spots on the dorsum above the spinnerets. *T. australe* has been established as a predator of the cotton fleahopper on cotton (Breene et al. 1989a) and also feeds upon the red imported fire ant (Nyffeler et al. 1988b).

The habitat preference of *T. australe* coincides with the linyphiid *Grammonota texana* on cotton. *T. australe's* presence on irregular webs built on the upper terminals is often at the base of fruit bracts, in the preferred habitat area of cotton fleahoppers. The two spider species seemed to be ecological equivalents in a cotton field in 1986 and 1987 near College Station, Texas. *G. texana* was present in 1986, and *T. australe* the following year (Breene et al. 1988a, 1989a).

*Theridion crispulum* Simon has a median band on a yellow white carapace, and the abdomen has a black pattern on a white background. It is found in the eastern half of Texas. The length of the female ranges from 1.4 to 2.6 mm; length of the male ranges from 1.2 to 1.6 mm. This spider is listed under the species name *intervallatum* in the revision (see Levi and Randolph 1975).

*Theridion flavonotatum* Becker (length of the female ranges from 1.4 to 2.6 mm; length of the male ranges from 1.4 to 2.3 mm) is another uncommon species on cotton found in the eastern half of Texas in July and August. The carapace is yellow white to orange, typically with a median dark band almost as wide as the posterior eye row. The abdomen is yellow to white.

*Theridion glaucescens* Becker (the female ranges from 1.6 to 3.0 mm long; the male ranges from 1.4 to 2.5 mm long) builds its web on the underside of cotton leaves in central and eastern Texas. The species is not common on cotton. The carapace is yellow, typically having a median dusky band and a dusky border, and a scalloped median band on the abdomen. The eggsacs are nearly spherical, yellow to tan, and contain 18 to 52 eggs.

*Theridion hidalgo* Levi has a yellow white carapace with a dark dusky or red band. The abdomen has a median scalloped white band on a gray spotted background. The length of the female ranges from 1.5 to 2.0 mm; length of the male ranges from 1.4 to 1.7 mm. It is found in the eastern half of Texas.

The cephalothorax of *Theridion murarium* Emerton has black marginal stripes and a black median band running longitudinally on a background of grayish yellow (Kaston 1978). The abdomen has a lighter, wavy longitudinal band surrounded with darker regions. The length of the female ranges from 2.8 to 4.3 mm; length of the male ranges from 2.1 to 3.2 mm. Webs are reported on the ground, under stones, in trees, grass, and bushes. The eggsacs measure 3 to 4 mm in diameter and contain about 30 eggs. The species is not common on cotton but is widespread in Texas, where it has been found from June to August.

*Theridion rabuni* Chamberlin and Ivie has a yellow white carapace that is dusky in the center and margined by a black line. The abdomen is white with a scalloped band. The length of the female ranges from 1.5 to 1.7 mm; length of the male ranges from 1.3 to 1.9 mm. The species is found more consistently in the northern half of Texas but is uncommon on cotton. Nyffeler et al. (1988b) observed this species consuming red imported fire ants.

The next two species of theridiids are not often seen in Texas cotton fields. The first is *Thymoites expulsus* (Gertsch and Mulaik), which has a black ring around the spinnerets. The female is 1.4 to 2.3 mm long; the male is 1.3 to 1.5 mm long. The species occurs in the eastern half of Texas.

The second is *Thymoites unimaculatus* (Emerton). The female ranges from 1.2 to 2.3 mm long; the male ranges from 1.4 to 1.9 mm long. The species has been collected from eastern Texas.

Both these small spiders make their webs on low vegetation, have orange legs, have the ocular area darkened, and have white abdomens. Eggsacs produced by these two species are whitish, are about 2 to 2.5 mm in diameter, and are composed of loose threads containing 22 to 38 eggs. These species were revised under the genus *Paidisca* (Levi 1957a).

Males of *Tidarren haemorrhoidale* (Bertkau) are easily distinguished by the presence of a large single left pedipalp. The shape and markings are similar to *T. sisphoides* (Walckenaer) but are smaller. The length of the female ranges from 2.4 to 3.7 mm; length of the male ranges from 0.9 to 1.4 mm. Levi et al. (1968) stated that the male amputates one of his own disproportionally large pedipalps before his last molt. The female's abdomen is dirty white with brown or black markings and has a white vertical stripe on the posterior of the abdomen.

Dean et al. (1982) noted that the species was generally seen on the lower half of the cotton plant late in the season in the eastern half of Texas. The female builds a retreat, typically consisting of a curled leaf, often in the upper sections of the web, which she also uses for concealing her eggsacs. Lubin (1984) found *T. sisyphoides*, a *Theridion* sp., and a scorpion species displaced by the invasion of the little fire ant, *Wasmannia auropunctata* (Roger), on the Galapagos Islands. Fire ants may displace *Tidarren* because they seldom are seen in cotton fields with fire ants. However, at least one species of theridiid, *Theridion australe* Banks, increases its numbers as ant numbers increase. The problem is interesting in that ants can successfully attack some web-weaving spiders but apparently cannot prey on others.

Species of theridiids, along with orb weaver species, compose most of the spiders that appear to exhibit a numerical response to high red imported fire ant numbers in cotton fields. Either the ants themselves make up a significant part of the spider diet or the spiders provide protection for ants in some significant manner or a combination of both (Breene 1991b).

Revisions of the theridiid genera can be found in Exline and Levi (1962) and Levi (1954, 1955a, b, 1956, 1957a, b, 1959a, b). Levi and Randolph (1975) present a key and checklist to the American theridiids.

## Thomisidae: Crab Spiders

A family of ambushers, the crab spiders are among the most widespread group of predators in agriculture. They are found, sometimes abundantly, on nearly every crop in the United States and on cotton in China (Zhao et al. 1980). The crab-like (laterigrade) legs are distinctly characteristic of the family; the first two pairs of legs are significantly longer and more robust than the last two pairs. Most of the species found on cotton are often observed near the top of the plant. The crab spiders are not known to build snares, retreats, molting webs, reproductive nests, or overwintering nests (Kaston 1978). Eggsacs are flat and may be attached to a substrate.

Without the assistance of silk, crab spiders catch their prey (which may often be quite large) using strength and a potent venom (Nyffeler and Benz 1981a). Crab spiders are often conspicuous on flowers, where they may prey upon social bees and other pollinating beneficial insects, creating doubt in some about their status as a beneficial predator. However, Nyffeler and Breene (1990b) provided evidence of a much wider prey spectrum, for which social bees composed only 3% of the crab spiders' total diet in European hay meadows. Araneophagy in crab spiders was reported by Nyffeler and Benz (1979b). Morse (1983, 1984) discusses in detail the techniques used by crab spiders when hunting on flowers.

*Misumenoides formosipes* (Walckenaer), a large crab spider, can change color to match more closely its surroundings. It is often found near the terminals on cotton or other plants. Coloration is variable; the background color is white or yellow, and broad red bands appear on the carapace of some. Fitch (1963) noted that the species is the most common of the spiders found on flowers maturing in late summer. Eggsacs are from 5 to 10 mm in diameter and are white, lens shaped, containing 100 or more eggs. Length of the female ranges from 5.0 to 11.3 mm; length of the male is from 2.5 to 3.2 mm. The distribution includes the entire United States. The species has been collected from May through September in Texas.

The dorsal surface of *Misumenops asperatus* (Hentz) is covered with short, rigid hairs arising from red impressions on a yellow or white background. The tibia and tarsi of leg I are ringed with red. The length of the female ranges from 4.4 to 6.0 mm; length of the male is from 3.0 to 4.0 mm. The species occurs in the eastern half of Texas.

*Misumenops celer* (Hentz) is the economically most important crab spider found on cotton. The carapace of the female is white to dull or bright yellow with a median X-shaped, white stain-like marking extending to the eyes. The body edges are red in the male. Some abdomens are marked with two black or red bands made up of five or six spots in the caudal half. The legs are light colored in females, but the first two pairs are ringed with red on the males. Length of the female ranges from 5 to 6 mm; length of the male is from 3 to 4 mm.

Plagens (1983) found *M. celer* to represent from 45 to 76% of spiders collected in Arizona cotton fields on a seasonal basis, and spiders composed from 44 to 58% of the total number of generalist predators. He noted that field numbers of the species kept rising throughout the season unless interrupted by insecticide applications. The species is known to be polyphagous (Whitcomb et al. 1963, Muniappan and Chada 1970a, Dean et al. 1987).

*Misumenops celer* was found in 1987 in higher numbers than any other arthropod predator on woolly croton, the major overwintering plant species for the cotton fleahopper. The species was ranked as the top spider predator overall of fleahoppers on woolly croton (Breene et al. 1988a), and on cotton it was ranked fifth in importance behind four other spider species (Breene et al. 1989a, 1990). It was the most abundant spider in western Texas (Dean and Sterling 1987). The species is found throughout Texas from May through September.

*Misumenops coloradensis* Gertsch prefers low vegetation and trees, according to Jennings (1971). Its coloration is similar to *M. asperatus*. Length of the female is about 4.7 mm; length of the male is about 3 mm. The species occurs in western Texas.

*Misumenops dubius* (Keyserling) is difficult to separate from *M. celer* because of its similar coloration. Length of the female is about 6.4 mm; length of the male is about 3 mm. The species is found in the eastern half of Texas from May through July.

*Misumenops oblongus* (Keyserling) is reported as being widespread in the United States but more common in the South (Kaston 1978). The overall color is light green to whitish to silvery white on the abdomen. This species has fewer, less conspicuous spines compared with other members of this genus. The eggsac has a thin, white cover woven over it and contains about 77 eggs. Length of the female ranges from 4.9 to 6.2 mm; length of the male is from 1.5 to 2.6 mm. It has been collected from May to August.

The cephalothorax and legs of *Synema parvula* (Hentz) are a yellow-tinted orange, and its abdomen is yellow with a conspicuously shaped, dark transverse band toward the posterior. Length of the female ranges from 2 to 3 mm; length of the male is about 2.3 mm. The species is only occasionally found on cotton in eastern Texas.

A tubercle on the posterior dorsal abdomen above the spinnerets sets *Tmarus* sp. apart from the other species. The overall coloration is brown with white or yellow patches. Length of the female ranges from 4.5 to 7 mm; length of the male is from 3 to 5 mm. The genus is found throughout the United States and southern Canada but is not often seen on cotton.

Unlike the other members of this genus, *Xysticus auctificus* Keyserling generally has been found on the ground in cotton fields. A U-shaped white marking is on the brownish carapace, a black spot is at the base, and another black spot is on either side. The markings are less distinct on males. The abdominal markings on the males are whitish with black spots. Length of the female is about 5.5 mm; length of the male is about 3.5 mm. The species occurs in the eastern half of Texas.

*Xysticus elegans* Keyserling is typically found near the apex of the cotton plant. Its overall color is brown, and the center of the carapace is lighter along the middle. Eggsacs are about 10.5 mm in diameter, white, with a semi-transparent sheen, and one side is flattened, containing from 47 to 138 eggs. Length of the female ranges from 8 to 10 mm; length of the male is from 6 to 7 mm. The species occurs in eastern Texas.

Of the four *Xysticus* species found on Texas cotton, only *Xysticus funestus* Keyserling periodically occurs in more than low numbers. This species is often found near the top of the plant but has also been collected in pitfall traps (Whitcomb et al. 1963). Thus, it is a prime candidate as a predator of fleahoppers and bollworm/budworm eggs and larvae. Kaston (1978) describes the overall body color as a light brownish yellow to rusty red and covered with tiny light spots. Length of the female ranges from 6 to 7 mm; length of the male is about 4 mm. The species is found throughout Texas from May through July.

The carapace of *Xysticus texanus* Banks has two broad, darkened side bands that coalesce in front. The abdomen appears dark gray from above. Length of the female is about 5.4 mm; length of the male is about 4.4 mm. The species is found in the eastern half of Texas.

Additional information on this genus can be found in Gertsch (1939) and Kaston (1978).

### Uloboridae: Hackled Orb Weavers

The uloborids may be distinguished from the other orb weavers by a horizontally oriented web usually built at the middle of the plant, approximately 10 to 15 mm in diameter. This web is unlike the more vertically oriented araneid webs (Nyffeler et al. 1989). Although the orb-weaving tetragnathids usually also spin a horizontal web, they have no series of feathery protrusions evident on the distal section of leg I tibia on the females. A pair of small humps at the highest point of the abdomen and the calamistrum on leg IV is well developed on the females.

The single species found on cotton, *Uloborus glomosus* (Walckenaer), is small (length of the female ranges from 2.8 to 4.3 mm; length of the male is from 2.3 to 3.2 mm) with grayish brown coloration. The eggsacs are elongate and light brown, about 6 mm in length with several papillae, and are suspended from or near the web. Each eggsac has about 50 eggs, and several occupy a single web. Reaching maturity in early summer (found from July through September), this spider family's lack of poison glands is unique among Texas cotton spiders. Instead, they depend upon elaborate wrapping techniques to subdue the prey.

In an east Texas cotton field, the prey of this species consisted largely of aphids that fell from leaves above the web (Nyffeler et al. 1989). These spiders were observed capturing predominantly adult dipterans and whiteflies in other habitats (Muma 1975). Uloborids are more numerous in the eastern half of Texas though often uncommon in cotton fields. Muma and Gertsch (1964) revised the family.

## Computer Modeling

TEXCIM50 (Sterling et al. 1992b) is a computer insect model that forecasts costs and benefits of control based on field counts of pests, injury, predators, weather, etc. It contains data on 10 groups of predators, four of which are groups of spiders. They include web-spinning, lynx, crab, and jumping spiders.

The following families are not included in TEXCIM50 because of their low numbers in cotton or the lack of information on their feeding habits: Anyphaenidae, Clubionidae (except for *C. inclusum*), Filistatidae, Gnaphosidae, Hahniidae, Lycosidae (but can be included with the lynx spiders), Mimetidae, Miturgidae, Mysmenidae, Nesticidae, and Pisauridae.

The web-spinning spiders include Araneidae, Dictynidae, Linyphiidae, Tetragnathidae, Theridiidae (which make up a large proportion, if not most of the web-weaving spiders), and Uloboridae.

The lynx spiders are considered important enough to make up their own major TEXCIM predator group. Included with the lynx spiders in TEXCIM is a sac spider, *C. inclusum* (Peck and Whitcomb 1970), a member of the family Clubionidae and a species thought important enough for use in TEXCIM but difficult to group together conveniently with other taxa.

Crab spiders are considered important enough to make up their own predator category in TEXCIM, which includes the Philodromidae and Thomisidae.

Jumping spiders (family Salticidae) make up the final group of spider predators in TEXCIM; some of the species are important predators of cotton fleahoppers.

## Call for Information

We solicit further material on any aspect of the spider species discussed or new data on hypotheses or suggestions occurring in this report. Send synopsis and complete references to D. Allen Dean, Department of Entomology, Texas A&M University, College Station, Texas 77843-2475 USA.

## Taxonomic Discussion

For simplification, we use an arrangement of families based on Kaston (1978) and Roth (1985). Brignoli (1983) and Platnick (1989) present new arrangements of families and transferred some genera to other families. For the most part, these changes have not affected the genera and species that occur in Texas cotton. In those instances that affect a taxon, a conservative approach has been taken if some uncertainty among specialists seems to remain. The family Clubionidae would be most affected by the new family arrangements of transferring *Castianeira* and *Trachelas* to Corinnidae and *Phrurotimpus* to Liocranidae.

Exceptions to this conservative approach exist for *Teminius*, which was transferred to Miturgidae. Platnick and Shadab (1989) gave convincing arguments for the reassignment of this genus. Although the most recent revisions listed the tetragnathines (including nephilines) and metines as subfamilies of the Araneidae (Levi 1980, 1981), and although Coddington (1990) noted only that the tetragnathines, metines, and nephilines were most closely related but without elevating them to family rank, a biological factor suggests that the two families should be separated. Of the Orbiculariae (orb weavers), the Uloboridae and Tetragnathidae (except nephilines) generally make orb webs that are somewhat horizontal. Nephilines and the members of Araneidae generally make vertical orb webs. However, nephilines seem to be more morphologically related to the tetragnathids than to the araneids, even though they have an araneid-like web orientation. Moreover, evidence suggests that the method of construction of the nephiline orb web is uniquely derived from the method used by tetragnathids, but not by araneids (Eberhard 1982). The only nephiline that might be found, *Nephila clavipes* (L.), has not yet been collected on Texas cotton, so confusion about the identity based on orb web type is unlikely to occur.

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## Illustration Credits

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# Glossary

**agroecosystems** - multiple agricultural ecosystems. A specific system (e. g., cotton) is a "cotton ecosystem" and includes the plants and associated animals.

**ALE** - the anterior lateral eyes.

**AME** - the anterior median eyes.

**annulated** - having ring-like markings, segments, or divisions typically on the legs.

**anteapical** - positioned just proximally to the apex.

**Anthocoridae (Hemiptera: Heteroptera)** - the family of minute pirate bugs; tiny beneficial search-and-destroy predators of sessile external pests.

**Anyphaenidae (Araneae)** - the family of the ghost spiders; similar in appearance to Clubionidae.

**apodeme** - the body wall invagination serving as a muscle attachment area.

**apophysis** - an evagination, more stout than a spine, typically on the legs or pedipalps.

**Aphididae (Hemiptera: Homoptera)** - the aphid family; a sessile external insect pest.

**Apidae (Hymenoptera)** - the family of bees including honey bees.

**arachnology** - the scientific study of arachnids.

**Araneae** - the arachnid order of spiders.

**Araneidae (Araneae)** - the orb weaver spider family.

**araneologist** - a biologist who specializes in the study of spiders.

**Araneomorphae (Araneae)** - one of the two infraorders of spiders, the other is Mygalomorphae.

**araneophagy** - predation upon spiders.

**booklung** - a respiratory organ with page-like folds in most spiders.

**boss** - a smooth, lateral structure at the base of the chelicerae in certain spiders.

**calamistrum** - a series of curved bristles on metatarsus IV in cribellate spiders.

**carapace** - the fused dorsal series of sclerites making up the cephalothorax.

**carina** - a keel-like structure on the forward clypeal edge of the carapace in certain spiders.

**caudad** - positioned toward the tail; posterior.

**caudal** - a tail or posterior end.

**cephalothorax** - a body region made up of the fused head and thorax.

**chela** - a pincer-like appendage as typified by scorpions.

**chelicerae** - the front paired jaws of spiders, each of which consists of a stocky basal segment (paturon) and a distal-pointed fang.

**chitin** - a nitrogenous polysaccharide $(C_8H_{13}NO_5)n$ occurring in the cuticle of arthropods.

**Chrysopidae (Neuroptera)** - the green lacewing family; beneficial search-and-destroy predators of sessile external pests.

**Cicadellidae (Hemiptera: Homoptera)** - the leafhopper family containing mobile, visually acute insect pests.

**Clubionidae (Araneae)** - the sac spider family.

**clypeus** - the space occupying the area between the anterior median eyes and the front edge of the carapace.

**Coccinellidae (Coleoptera)** - the family of lady beetles; largely search-and-destroy predators of sessile external pests.

**Coleoptera** - the insect order of beetles.

**colulus** - a non-silk-spinning, possibly vestigial spider appendage resembling a spinneret positioned in front of the anterior spinnerets.

**comb** - single bristles with barbs that make up a comb on tarsus IV in theridiids and nesticids; used to "comb" out silk onto prey.

**conspecific** - members of the same species.

**cribellum** - a silk-spinning transverse plate-like organ in front of the spinnerets in cribellate spiders.

**Curculionidae (Coleoptera)** - the family of weevils, including the boll weevil.

**cursorial** - adapted for walking or running.

**cymbium** - tarsal elements of the male spider pedipalps hollowed out to encompass the copulatory organs.

**Dictynidae (Araneae)** - the mesh web spider family.

**Diptera** - the order of flies.

**dorsal** - situated near the top or above other sections.

**edaphic** - of or relating to the soil.

**eggsac** - spider eggs enclosed in silk.

**embolus** - the part of the male spider copulatory organ through which sperm pass into the female.

**endite** - the enlarged basal ventral segment of the pedipalp that may function as a crushing jaw.

**entomophagous** - feeding on insects.

**epigastric furrow** - a region on the ventral abdomen near the genital opening of spiders.

**epigynum** - a ventral abdominal sclerite of the female reproductive openings.

**exuviae** - the cast "skin," i. e., the old exoskeleton of an arthropod.

**fangs** - claw-like segment of the spider chelicerae.

**Filistatidae (Araneae)** - the crevice spider family.

**folium** - pigmented design or pattern on the dorsal abdomen often shaped like a leaf.

**Formicidae (Hymenoptera)** - the insect family of ants.

**frass** - the dry, compacted waste products of insect larvae, e. g., of Lepidoptera and Coleoptera.

**generalist predator** - a predator that may attack many different types of prey.

**geniculate** - elbowed or bent at a right angle.

**Gnaphosidae (Araneae)** - the family of ground spiders.

**guild** - all taxa in a community that use similar resources such as food or space.

**Hahniidae (Araneae)** - the sheet web weaver family of spiders.

**Hemerobiidae (Neuroptera)** - the family of brown lacewings; largely search-and-destroy predators of sessile external pests.

**Hemiptera** - the insect order containing the suborders Heteroptera and Homoptera.

**heterogeneous** - the characteristic wherein some eyes (usually the AME) are dark in color; the remaining eyes are light in color.

**Heteroptera** - "true" bugs, a suborder of the insect order Hemiptera including aphids, leafhoppers, treehoppers.

**Hexapoda, also Insecta** - the class of insects.

**homogeneous** - the condition in which all eyes are the same color.

**Homoptera** - a suborder of the insect order Hemiptera.

**Hymenoptera** - the insect order of bees, wasps, and ants.

**immature** - a non-adult arthropod.

**instar** - the stage of the arthropod between successive molts, e. g., the fourth instar.

**intraguild** - existing among different species of a guild.

**IPM** - Integrated pest management, a term applied to the integration of various control techniques such as biological, cultural, and chemical control.

**kleptoparasitic** - the stealing of prey caught by another predator.

**labium** - the lower lip between the two endites of spiders.

**lamelliform** - flattened as in certain claw-tufts of spiders.

**laterigrade** - the way in which the legs are turned in certain spiders so that the dorsal surfaces are positioned retrolaterally; crab-like.

**Lepidoptera** - the insect order of butterflies and moths.

**Linyphiidae (Araneae)** - the line-weaving spider family.

**lorum** - a set of plate-like sclerites positioned dorsally on the spider pedicel.

**Lycosidae (Araneae)** - the wolf spider family.

**Lygaeidae (Hemiptera: Heteroptera)** - the family of seed bugs, many of which, as typified by the big-eyed bugs, are beneficial predators.

**Membracidae (Hemiptera: Homoptera)** - the treehopper family, some of which are pests.

**Mimetidae (Araneae)** - the family of pirate spiders.

**Miridae (Hemiptera: Heteroptera)** - the insect family of plant or leaf bugs. A few are beneficial and some are probably not. The cotton fleahopper may be a pest in the early cotton season and a predator later.

**Mygalomorphae (Araneae)** - one of the two infraorders of spiders; the other is Araneomorphae.

**Nabidae (Hemiptera: Heteroptera)** - a family of largely beneficial predacious insects.

**Nesticidae (Araneae)** - the family of cave spiders.

**Neuroptera** - the insect order of alderflies, dobsonflies, fishflies, snakeflies, lacewings, antlions, and owlflies. Considered nearly 100% beneficial; however, many snakeflies consume spider eggs.

**Odonata** - the insect order of dragonflies and damselflies. Considered nearly 100% beneficial.

**oophagy** - predation upon eggs.

**Orthognatha** - a suborder of spiders no longer used.

**Oxyopidae (Araneae)** - the lynx spider family.

**palp** - all segments of the pedipalp distal to the endite or coxa. The tarsal segment contains the sperm storage area and intromittent organ of male spiders.

**papillae** - tubercle extensions.

**pedicel** - a stalk-like structure connecting the cephalothorax to the abdomen.

**pedipalp** - the second pair of appendages on the cephalothorax behind the chelicerae in spiders.

**Philodromidae (Araneae)** - the family of running crab spiders.

**phytophagous** - feeding on plant materials.

**Pisauridae (Araneae)** - the nursery-web spider family, including the fishing spiders.

**PLE** - posterior lateral eyes.

**PME** - posterior median eyes.

**procurved** - a curved arc, typically of an eye row, such that the ends are nearer than its center to the front of the body (see recurved).

**promargin** - the margin of the cheliceral fang furrow closer to the front of the body, away from the endite (see retromargin).

**raptorial** - adapted for grasping prey with the front legs.

**recurved** - a curved arc such that the ends are nearer than its center to the posterior of the body (see procurved).

**retromargin** - the margin of the cheliceral fang furrow farther from the front of the body, nearer the endite (see promargin).

**Salticidae (Araneae)** - the family of jumping spiders.

**saltorial** - adapted for jumping.

**scape** - a projection on the midline of the epigynum in certain spiders.

**sclerite** - a hardened body wall plate bounded by sutures or membranes.

**scopula** - a brush of hairs on certain spiders on the tarsus and metatarsus.

**spermatheca** - a sperm storage organ in females.

**spinnerets** - the silk-spinning, paired appendages on the end of the abdomen.

**stabilimentum** - the bands of silk spun by certain orb weaver species in their webs.

**sternum** - the central ventral wall of the cephalothorax.

**Tetragnathidae (Araneae)** - the long-jawed orb weaver spider family.

**Theridiidae (Araneae)** - the comb-footed spider family.

**Thomisidae (Araneae)** - the crab spider family.

**trichobothrium** - a fine sensory hair protruding at right angles from the legs.

**Uloboridae (Araneae)** - the horizontal orb weaver spider family.

**univoltine** - having a single generation per year.

**venter** - the bottom side of a spider.

# Spiders of Texas Cotton

**Family Anyphaenidae**
*Aysha gracilis* (Hentz)
*Teudis mordax* (O.P.-Cambridge)
*Wulfila saltabundus* (Hentz)

**Family Araneidae**
*Acacesia hamata* (Hentz)
*Acanthepeira cherokee* Levi
*Acanthepeira stellata* (Walckenaer)
*Araniella displicata* (Hentz)
*Argiope aurantia* Lucas
*Argiope trifasciata* (Forskal)
*Cyclosa turbinata* (Walckenaer)
*Eriophora ravilla* (C.L. Koch)
*Eustala anastera* (Walckenaer)
*Eustala cepina* (Walckenaer)
*Gea heptagon* (Hentz)
*Hypsosinga rubens* (Hentz)
*Mangora fascialata* Franganillo
*Mangora gibberosa* (Hentz)
*Mecynogea lemniscata* (Walckenaer)
*Metazygia wittfeldae* (McCook)
*Micrathena gracilis* (Walckenaer)
*Micrathena sagittata* (Walckenaer)
*Neoscona arabesca* (Walckenaer)
*Neoscona utahana* (Chamberlin)

**Family Clubionidae**
*Castianeira crocata* (Hentz)
*Castianeira gertschi* Kaston
*Castianeira longipalpus* (Hentz)
*Cheiracanthium inclusum* (Hentz)
*Clubiona abboti* L. Koch
*Phrurotimpus* spp.
*Trachelas deceptus* (Banks)
*Trachelas volutus* Gertsch

**Family Dictynidae**
*Dictyna annexa* Gertsch & Mulaik
*Dictyna consulta* Gertsch & Ivie
*Dictyna mulegensis* Chamberlin
*Dictyna reticulata* Gertsch & Ivie
*Dictyna roscida* (Hentz)
*Dictyna segregata* Gertsch & Mulaik
*Dictyna volucripes* Keyserling

**Family Filistatidae**
*Kukulcania hibernalis* (Hentz)

**Family Gnaphosidae**
*Drassyllus inanus* Chamberlin & Gertsch
*Drassyllus notonus* Chamberlin
*Gnaphosa altudona* Chamberlin
*Gnaphosa sericata* (L. Koch)
*Micaria deserticola* Gertsch
*Micaria longipes* Emerton
*Micaria vinnula* Gertsch & Davis
*Nodocion floridanus* (Banks)
*Sergiolus ocellatus* (Walckenaer)
*Synaphosus paludis* (Chamberlin & Gertsch)
*Talanites captiosus* (Gertsch & Davis)

**Family Hahniidae**
*Neoantistea mulaiki* Gertsch

**Family Linyphiidae**
*Ceraticelus* spp.
*Ceratinops* spp.
*Ceratinopsis* spp.
*Eperigone eschatologica* (Crosby)
*Erigone autumnalis* Emerton
*Erigone dentigera* O.P.-Cambridge
*Frontinella pyramitela* (Walckenaer)
*Grammonota texana* (Banks)
*Meioneta* spp.
*Tennesseellum formicum* (Emerton)
*Walckenaeria spiralis* (Emerton)

**Family Lycosidae**
*Allocosa absoluta* (Gertsch)
*Hogna antelucana* (Montgomery)
*Hogna helluo* group nr. *georgicola* (Walckenaer)
*Pardosa atlantica* Emerton
*Pardosa delicatula* Gertsch & Wallace
*Pardosa milvina* (Hentz)
*Pardosa pauxilla* Montgomery
*Pardosa sternalis* (Thorell)
*Pirata davisi* Wallace & Exline
*Pirata seminola* Gertsch & Wallace
*Rabidosa rabida* (Walckenaer)
*Schizocosa avida* (Walckenaer)
*Varacosa acompa* (Chamberlin)

**Family Mimetidae**
*Ero* sp.
*Mimetus hesperus* Chamberlin
*Mimetus notius* Chamberlin
*Mimetus puritanus* Chamberlin

**Family Miturgidae**
*Teminius affinis* Banks

**Family Mysmenidae**
*Calodipoena incredula* Gertsch & Davis

**Family Nesticidae**
*Eidmannella pallida* (Emerton)

**Family Oxyopidae**
- *Oxyopes apollo* Brady
- *Oxyopes salticus* Hentz
- *Peucetia viridans* (Hentz)

**Family Philodromidae**
- *Ebo punctatus* Sauer & Platnick
- *Philodromus pratariae* (Scheffer)
- *Thanatus formicinus* (Clerck)
- *Tibellus duttoni* (Hentz)

**Family Pisauridae**
- *Dolomedes triton* (Walckenaer)

**Family Salticidae**
- *Admestina tibialis* (C. L. Koch)
- *Agassa cyanea* (Hentz)
- *Eris militaris* (Hentz)
- *Habronattus coecatus* (Hentz)
- *Hentzia mitrata* (Hentz)
- *Hentzia palmarum* (Hentz)
- *Lyssomanes viridis* (Walckenaer)
- *Marpissa formosa* (Banks)
- *Marpissa lineata* (C .L. Koch)
- *Marpissa pikei* (G. & E. Peckham)
- *Metaphidippus chera* (Chamberlin)
- *Metaphidippus exiguus* (Banks)
- *Metaphidippus galathea* (Walckenaer)
- *Phidippus audax* (Hentz)
- *Phidippus cardinalis* (Hentz)
- *Phidippus clarus* Keyserling
- *Phidippus texanus* Banks
- *Sarinda hentzi* (Banks)
- *Sassacus papenhoei* (G. & E. Peckham)
- *Sitticus dorsatus* (Banks)
- *Thiodina puerpera* (Hentz)
- *Thiodina sylvana* (Hentz)
- *Zygoballus nervosus* (G. & E. Peckham)
- *Zygoballus rufipes* G & E. Peckham

**Family Tetragnathidae**
- *Glenognatha foxi* (McCook)
- *Tetragnatha laboriosa* Hentz

**Family Theridiidae**
- *Achaearanea globosa* (Hentz)
- *Anelosimus studiosus* (Hentz)
- *Argyrodes trigonum* (Hentz)
- *Coleosoma acutiventer* (Keyserling)
- *Euryopis* sp.
- *Latrodectus mactans* (Fab.)
- *Steatoda triangulosa* (Walckenaer)
- *Theridion australe* Banks
- *Theridion crispulum* Simon
- *Theridion flavonotatum* Becker
- *Theridion glaucescens* Becker
- *Theridion hidalgo* Levi
- *Theridion murarium* Emerton
- *Theridion rabuni* Chamberlin & Ivie
- *Thymoites expulsus* (Gertsch & Mulaik)
- *Thymoites unimaculatus* (Emerton)
- *Tidarren haemorrhoidale* (Bertkau)

**Family Thomisidae**
- *Misumenoides formosipes* (Walckenaer)
- *Misumenops asperatus* (Hentz)
- *Misumenops celer* (Hentz)
- *Misumenops coloradensis* Gertsch
- *Misumenops dubius* (Keyserling)
- *Misumenops oblongus* (Keyserling)
- *Synema parvula* (Hentz)
- *Tmarus* sp.
- *Xysticus auctificus* Keyserling
- *Xysticus elegans* Keyserling
- *Xysticus funestus* Keyserling
- *Xysticus texanus* Banks

**Family Uloboridae**
- *Uloborus glomosus* (Walckenaer)

# Synonymy

This list shows the old scientific names of species and their new names (old = new).

**Family Filistatidae**
*Filistata hibernalis = Kukulcania hibernalis*

**Family Gnaphosidae**
*Rachodrassus captiosus = Talanites captiosus*

**Family Linyphiidae**
*Frontinella communis = Frontinella pyramitela*

**Family Lycosidae**
*Lycosa abdita = Varacosa acompa*
*Lycosa acompa = Varacosa acompa*
*Lycosa antelucana = Hogna antelucana*
*Lycosa helluo = Hogna helluo*
*Lycosa rabida = Rabidosa rabida*

**Family Miturgidae**
*Syrisca affinis = Teminius affinis*

**Family Mysmenidae**
*Mysmena incredula = Calodipoena incredula*

**Family Nesticidae**
*Nesticus pallidus = Eidmannella pallida*

**Family Salticidae**
*Eris marginata = Eris militaris*
*Habronattus coronatus = Habronattus coecatus*
*Myrmarachne hentzi = Sarinda hentzi*
*Pellenes coronatus = Habronattus coecatus*
*Phidippus peritus = Phidippus texanus*
*Sitticus absolutus = Sitticus dorsatus*
*Zygoballus bettini = Zygoballus rufipes*

**Family Theridiidae**
*Paidisca = Thymoites*
*Theridion intervallatum = Theridion crispulum*
*Tidarren sisyphoides = Tidarren haemorrhoidale* (misidentification)

**Family Thomisidae**
*Misumenoides aleatorius = Misumenoides formosipes*

# Key to the Spiders of Texas Cotton

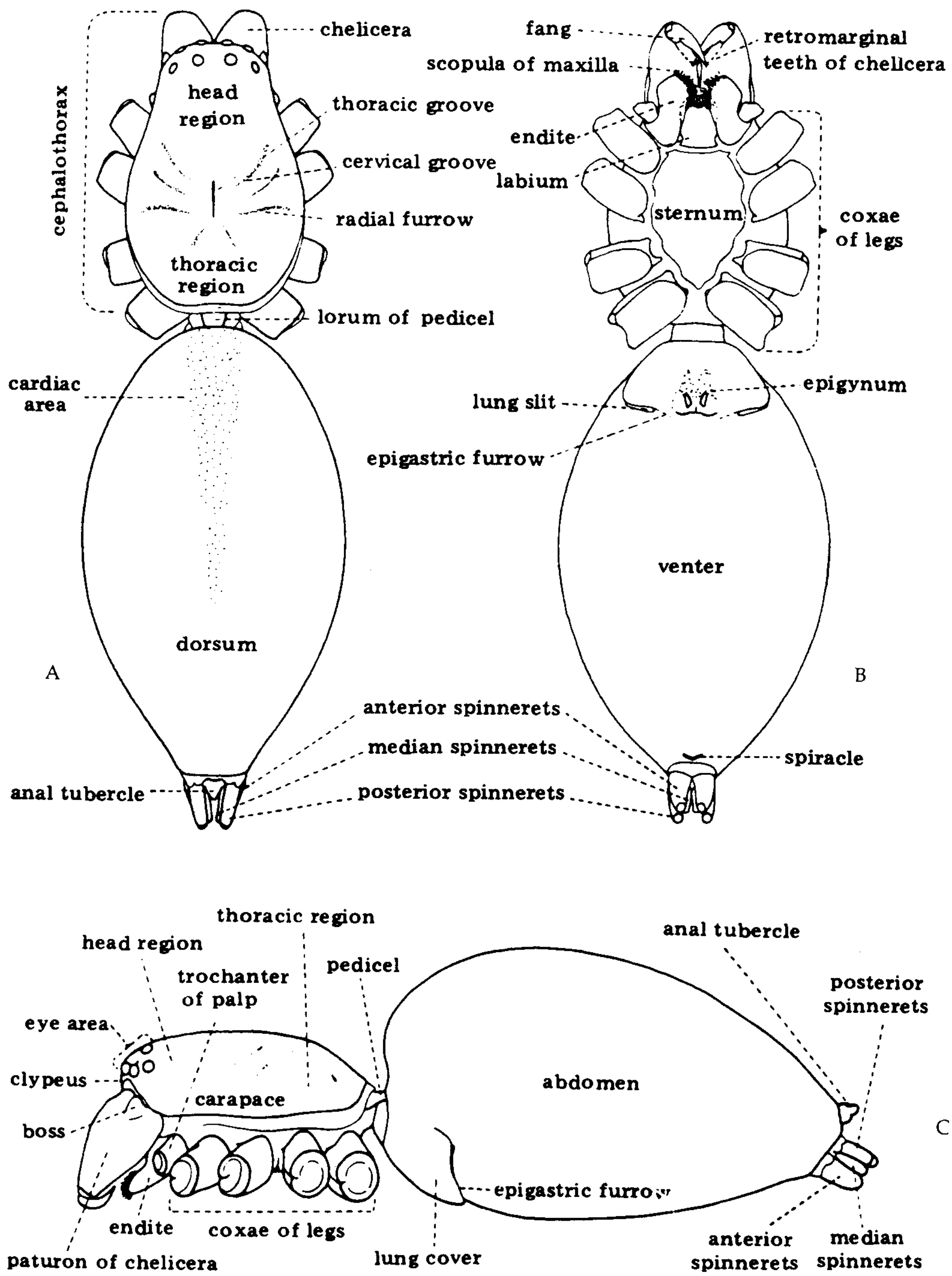



Figure 1. Major spider characteristics; A: dorsal view; B: ventral view; C: lateral view.

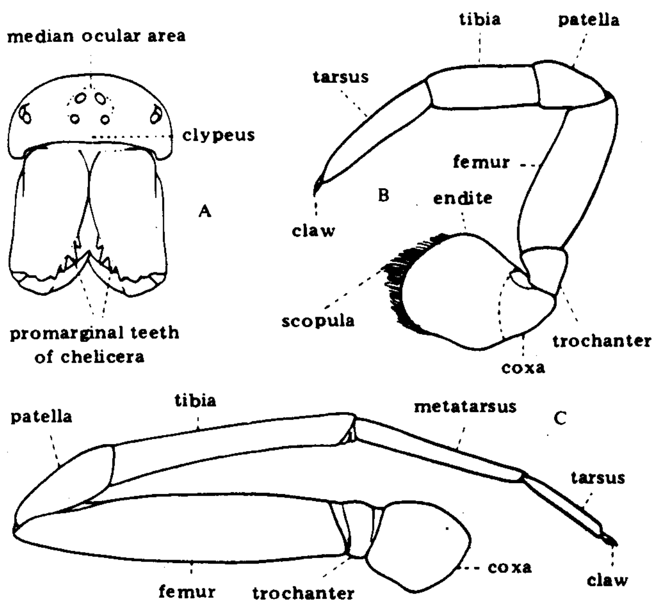



Figure 2. Major characteristics; A: frontal view of chelicerae, face, and eye region; B: female pedipalp; C: leg.

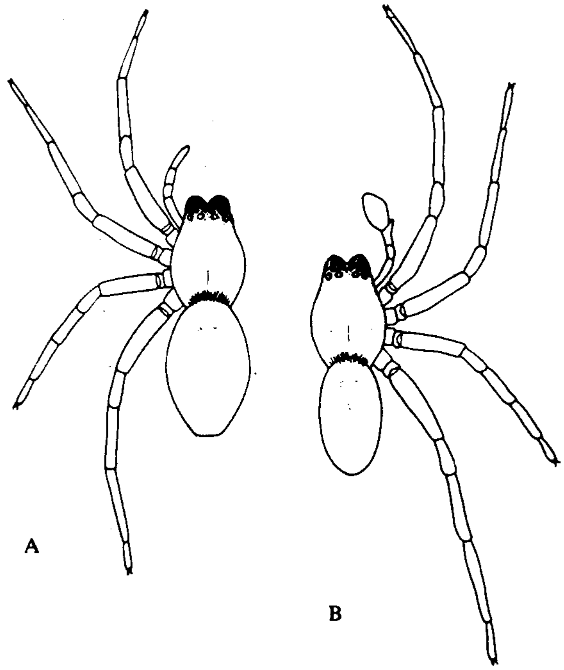



Figure 3. Comparison of adult spiders; A: female, B: male.

1a A cribellum on the underside in front of the spinnerets and a calamistrum on the metatarsus of leg IV present (Figs. 4, 5) .......... 2
1b Cribellum and calamistrum absent .......... 4

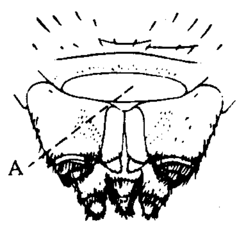



Figure 4. Cribellum (A) anterior to spinnerets on venter of abdomen.

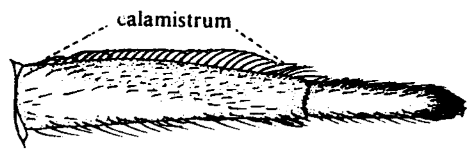



Figure 5. Metatarsus IV with calamistrum.

2a Chelicerae fused, eyes close together (Figs. 6, 7)...**Filistatidae** (1 species) .................................. *Kukulcania hibernalis* **(Hentz)**
2b Chelicerae not fused; eyes not as close together ........................................................................................................ 3

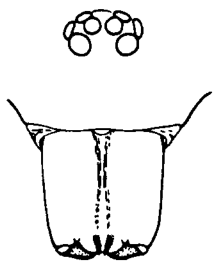
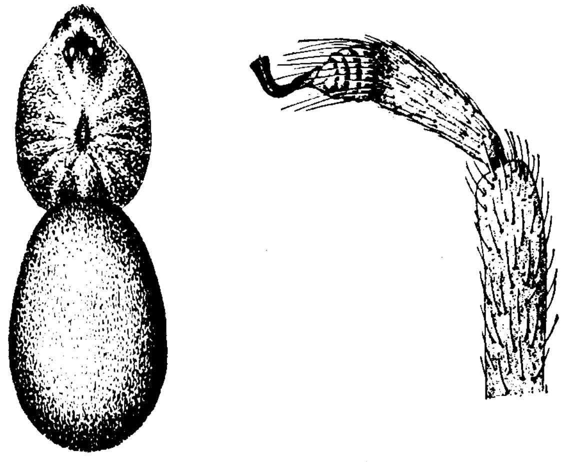


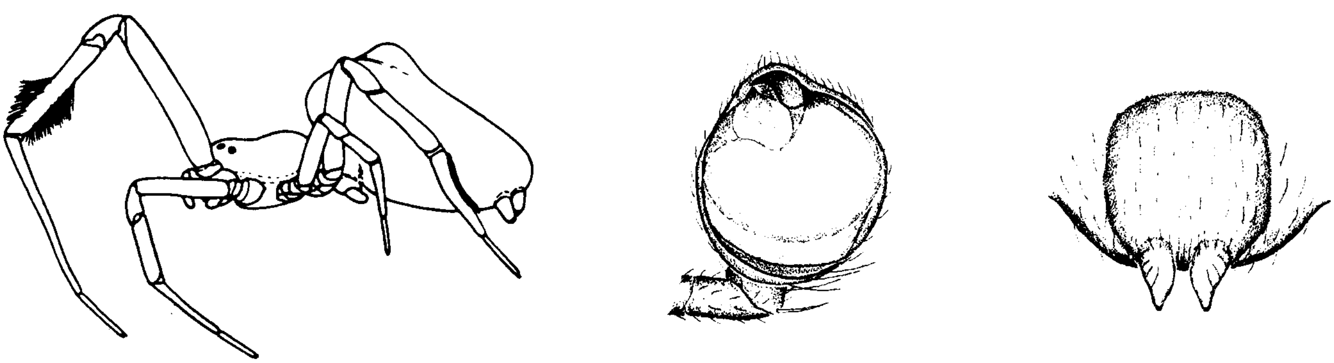
Figure 6. Frontal view of face; eyes and chelicerae of *Kukulcania*.



A B

Figure 7. *Kukulcania hibernalis* (Hentz); A: dorsum of female, B: male palp.

3a Eyes homogeneous (dark), both rows recurved; hair fringes on leg I tibia (Fig. 8)...**Uloboridae** (1 species) ..........................
.............................................................................................................................. *Uloborus glomosus* **(Walckenaer)**
3b Eyes heterogeneous; only anterior median eyes dark, anterior row straight; no hair fringes...**Dictynidae** (7 species) (Figs. 10 to 16) ................................................................................................................................. *Dictyna* **spp.**



A B C

Figure 8. *Uloborus glomosus* (Walckenaer); A: lateral view of female, B: palp (ectal view), C: epigynum.

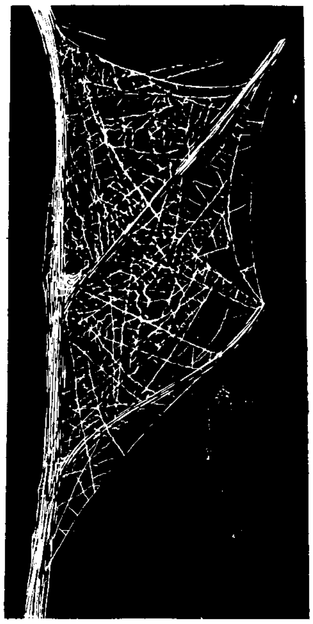


Figure 9. Irregular web typical of certain members of the family Dictynidae.

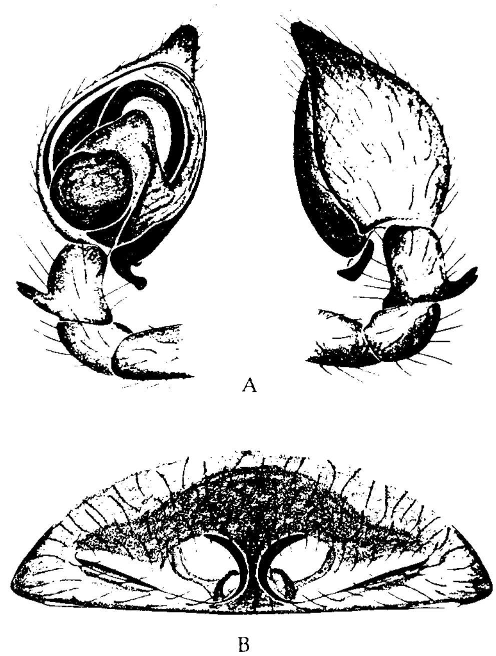



Figure 10. *Dictyna annexa* Gertsch & Mulaik; A: palp (ventral, retrolateral views), B: epigynum.

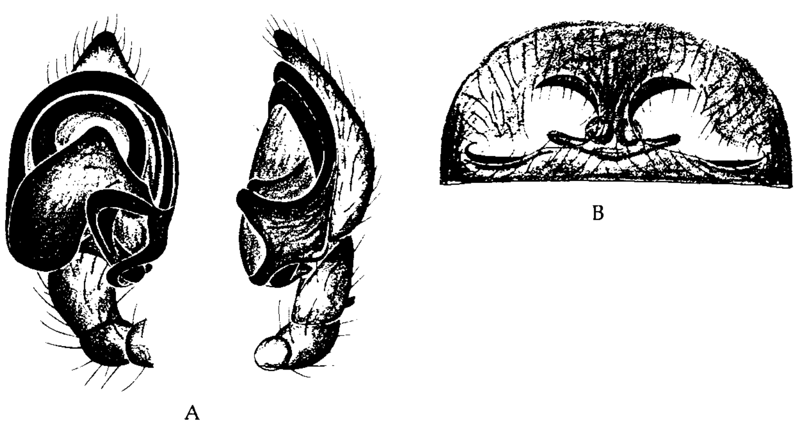



Figure 11. *Dictyna consulta* Gertsch & Ivie; A: palp (ventral, retrolateral views), B: epigynum.

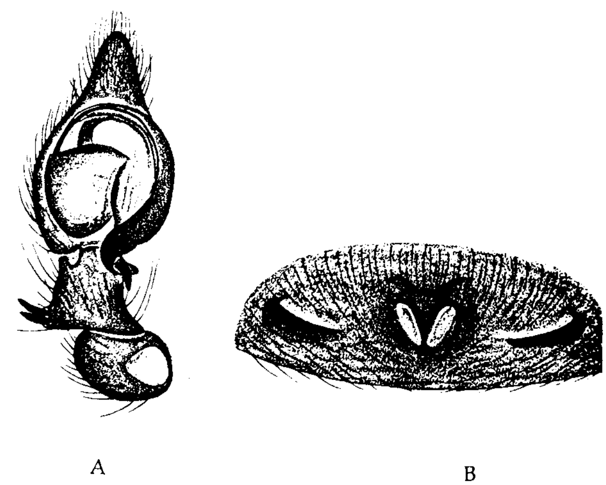



Figure 12. *Dictyna mulegensis* Chamberlin; A: palp, B: epigynum.

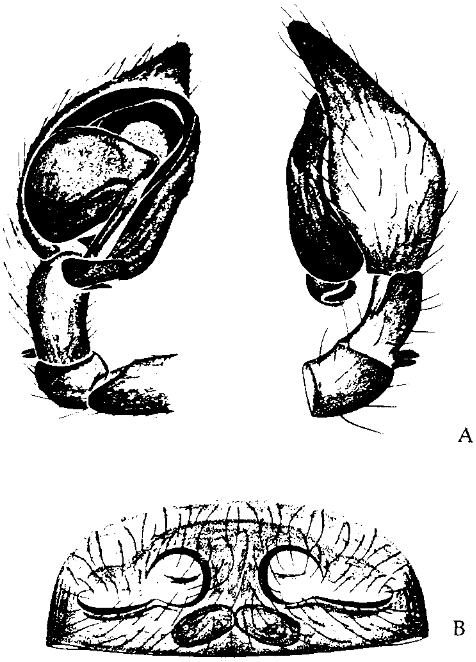



Figure 13. *Dictyna reticulata* Gertsch & Ivie; A: palp (ventral, retrolateral views), B: epigynum.

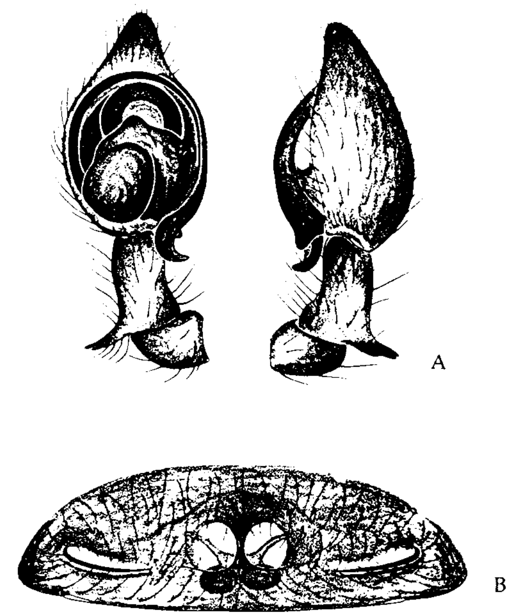



Figure 14. *Dictyna roscida* (Hentz); A: palp (ventral, retrolateral views), B: epigynum.

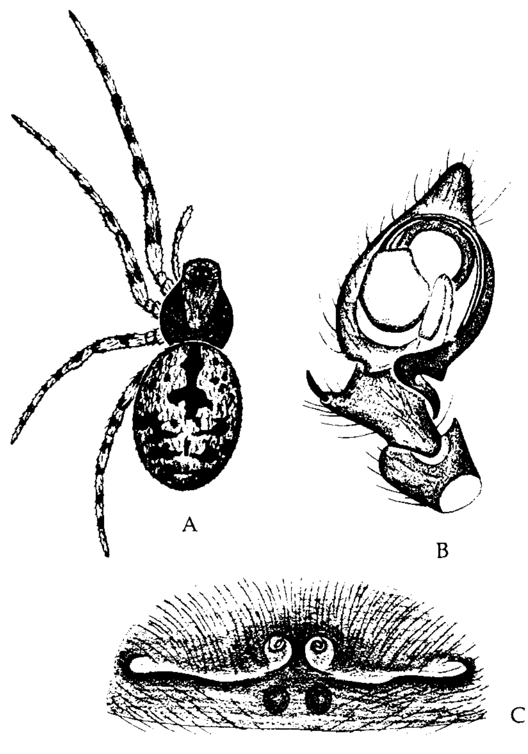



Figure 15. *Dictyna segregata* Gertsch & Mulaik; A: dorsum of female, B: palp, C: epigynum.

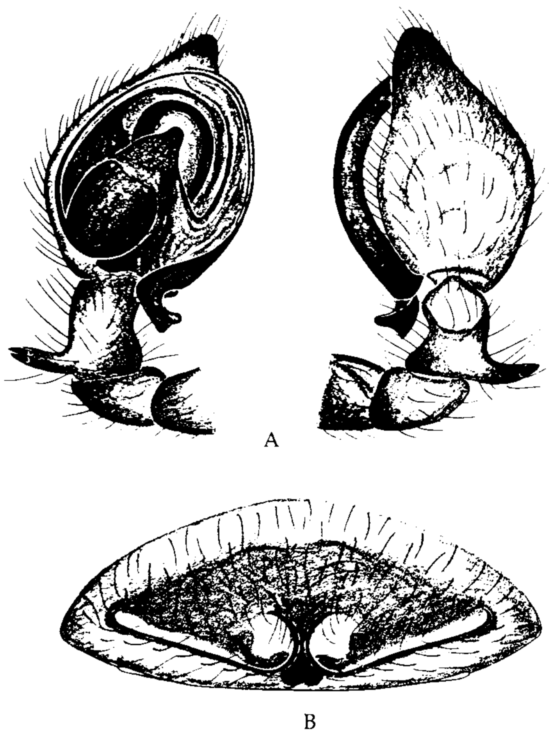



Figure 16. *Dictyna volucripes* Keyserling; A: palp (ventral, retrolateral views), B: epigynum.

4a Six to 10 serrated comb-like bristles (Fig. 17) present on ventral side of tarsus of leg IV ........ 5
4b Comb-like bristles on ventral side of leg IV absent ........ 22

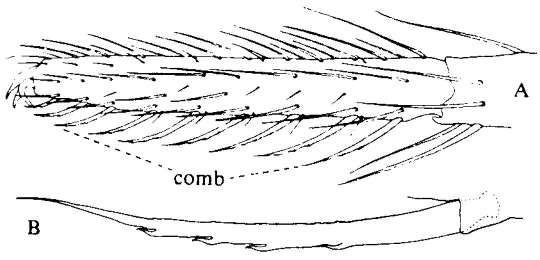



Figure 17. A: Comb structures of Theridiidae on tarsus IV, B: single bristle.

5a Anterior part of labium thickened, comb-like bristles not longer than the dorsal leg IV tarsus bristles...**Nesticidae** (1 species) (Fig. 18) ........ *Eidmannella pallida* **(Emerton)**
5b Anterior part of labium not thickened, comb-like bristles on leg IV longer than dorsal bristles...**Theridiidae** (17 species) .. ........ 6

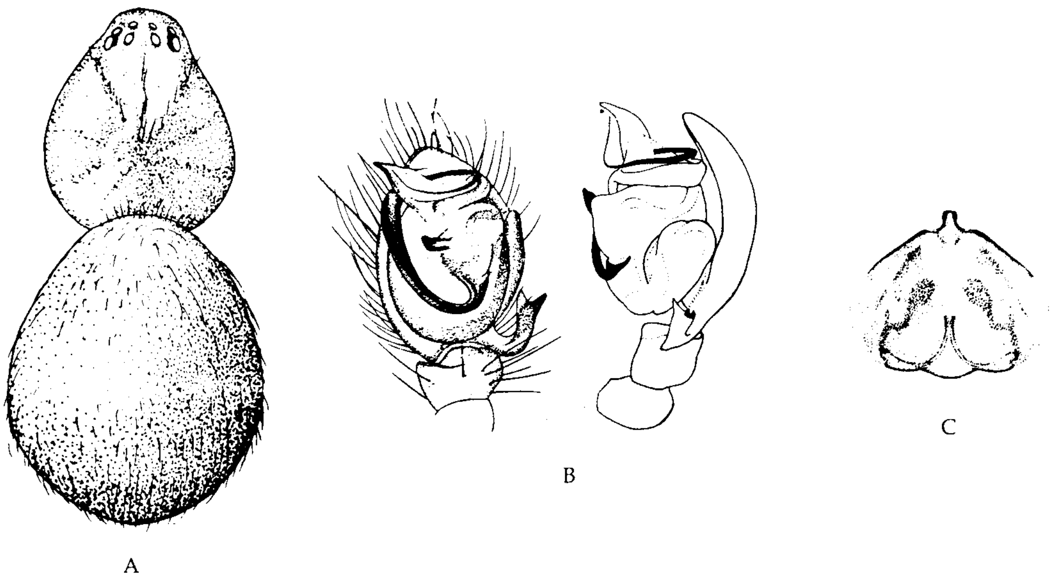



Figure 18. *Eidmannella pallida* (Emerton); A: dorsum, B: palp (ventral, retrolateral views), C: epigynum.

6a A fleshy colulus present between anterior spinnerets, or the colulus is indicated by a pair of setae (Fig. 19) .......................7
6b Colulus absent .......................................................................................................................................10

7a Colulus indicated only by a pair of setae (Figs. 19 to 20) ................................................... *Anelosimus studiosus* (**Hentz**)
7b Colulus present (Fig. 69) ..............................................................................................................................8

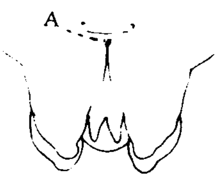



Figure 19. Colulus indicated by two setae (A).

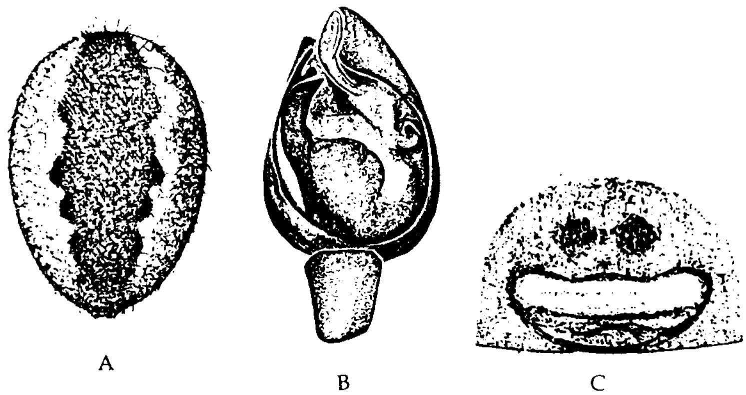



Figure 20. *Anelosimus studiosus* (Hentz); A: abdomen, B: palp, C: epigynum.

8a Female abdomen higher than long, triangular, typically with silver coloration on abdomen (Fig. 21) ...................................
........................................................................................................................ *Argyrodes trigonum* (**Hentz**)
8b Abdomen without these characteristics ........................................................................................................9

9a Abdomen with a purplish brown pattern on the dorsum with a yellow background (Fig. 22) ................................................
.................................................................................................................... *Steatoda triangulosa* (**Walckenaer**)
9b Abdomen black to brown without a dorsal pattern or with red stripes and/or red dots (Fig. 23), red hourglass on venter of abdomen that may vary in shape .................................................................................... *Latrodectus mactans* (**Fab.**)

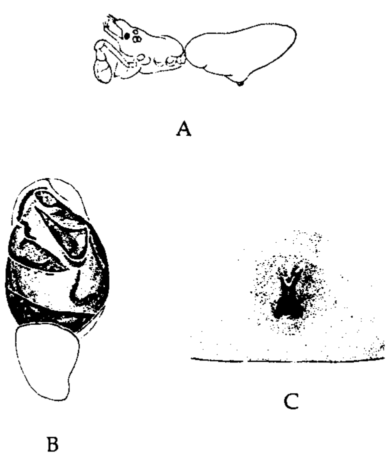



Figure 21. *Argyrodes trigonum* (Hentz); A: lateral view of male, B: palp, C: epigynum.

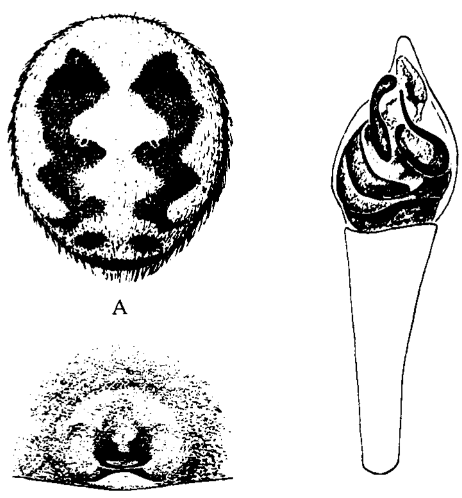
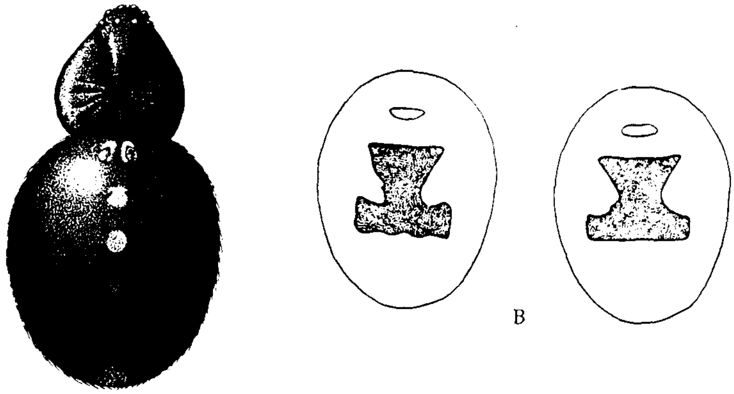
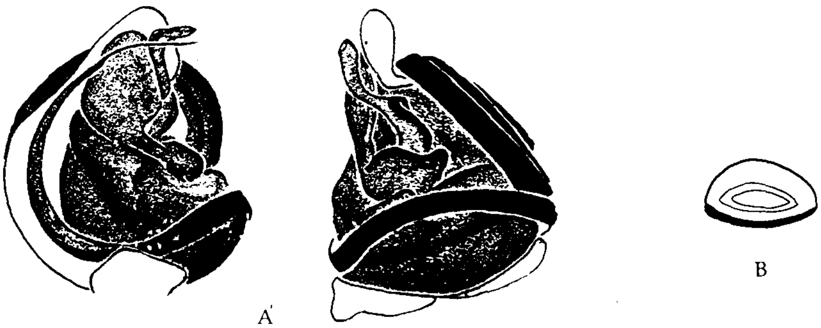



Figure 22. *Steatoda triangulosa* (Walckenaer); A: abdomen of female, B: palp, C: epigynum.



A B

Figure 23. *Latrodectus mactans* (Fab.); A: dorsum of female, B: two varieties of hourglass markings.



A B

Figure 24. *Latrodectus mactans* (Fab.); A: palp (mesal, ventral views); B: epigynum.

10a Abdomen triangular with the widest portion at the dorsal anterior over the pedicel (Fig. 25) .............................. *Euryopis* **sp.**
10b Abdomen not triangular .............................................................................................................................. 11

11a Abdomen distinctly higher than long (Fig. 26) ................................................................................................ 12
11b Abdomen not distinctly higher than long ........................................................................................................ 13

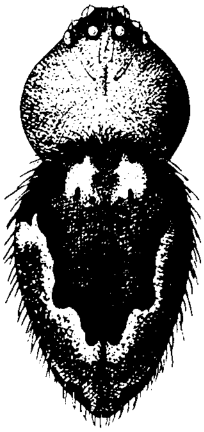


Figure 25. *Euryopis* sp.; dorsum of female.

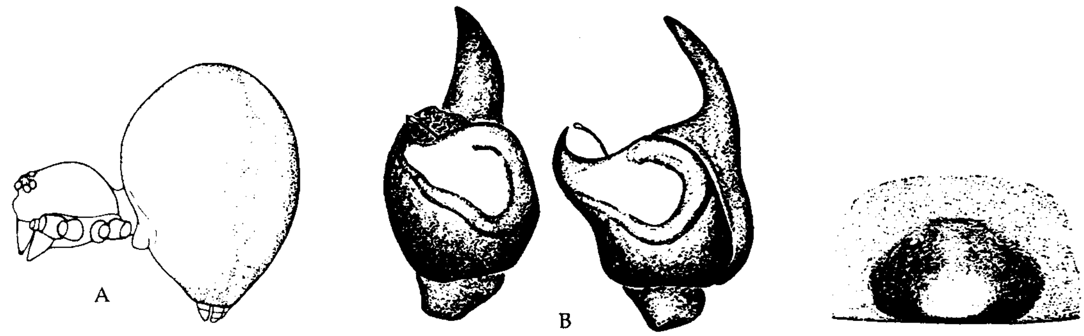



Figure 26. *Achaearanea globosa* (Hentz); A: female (lateral view), B: palp (ventral, ectal views), C: epigynum.

12a Posterior half of the abdomen is white with a black spot (Fig. 26) ................................................ *Achaearanea globosa* **(Hentz)**
12b Vertical white stripe on the posterior of the abdomen (Fig. 27) ............................................ *Tidarren haemorrhoidale* **(Bertkau)**

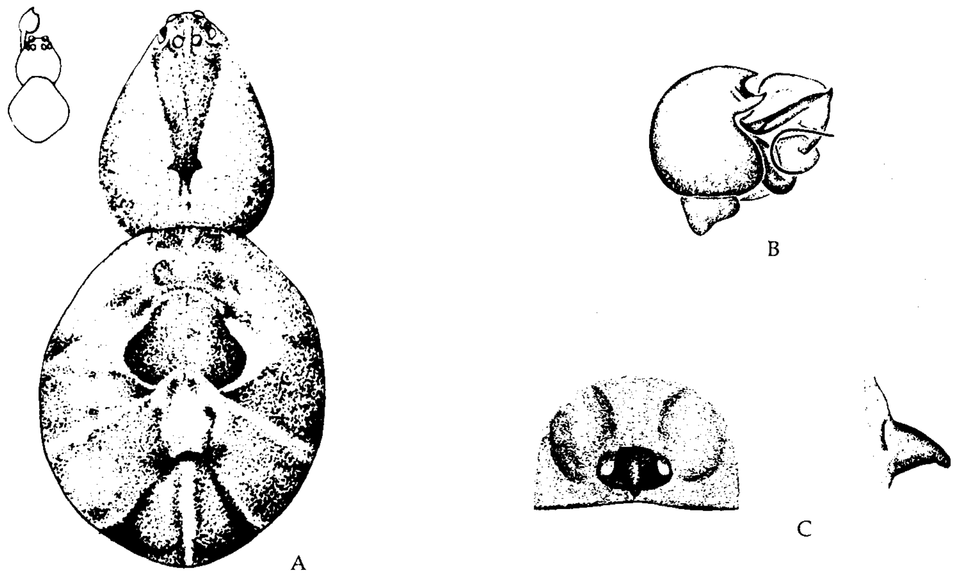



Figure 27. Shape of *Tidarren haemorrhoidale* (Bertkau); A: both sexes are shown at same scale (male on left), B: palp, C: epigynum (ventral, lateral views).

13a Adults less than 2.5 mm in body length; black areas surround the eyes, spinnerets, and the mid-dorsum ........................ 14
13b Adults generally greater than 2.5 mm in body length; lacking specific blackened areas ........................ 15

14a Black ring present around the spinnerets (Fig. 28) ........................ *Thymoites unimaculatus* **(Emerton)**
14b Black ring absent; genitalia different (Fig. 29) ........................ *Thymoites expulsus* **(Gertsch & Mulaik)**

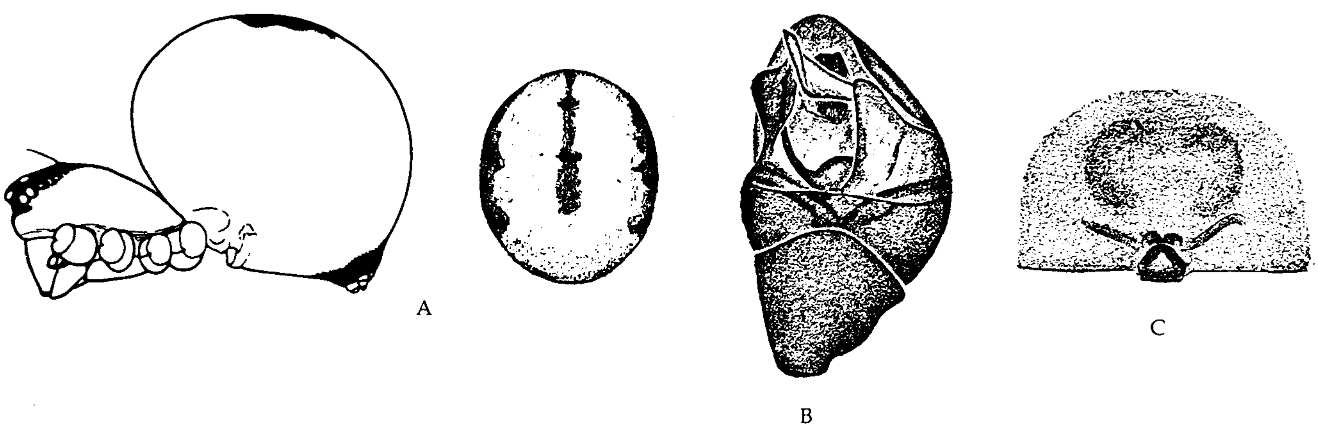
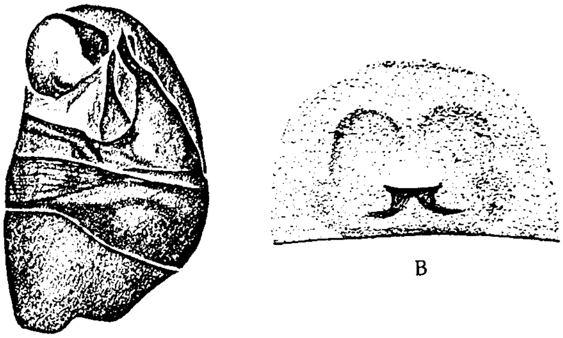



Figure 28. *Thymoites unimaculatus* (Emerton); A: lateral view, dorsal abdomen of female, B: palp, C: epigynum.

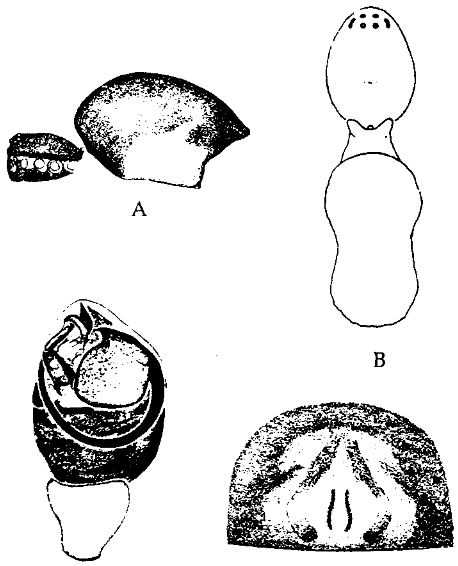


A B

Figure 29. *Thymoites expulsus* (Gertsch & Mulaik); A: palp, B: epigynum.

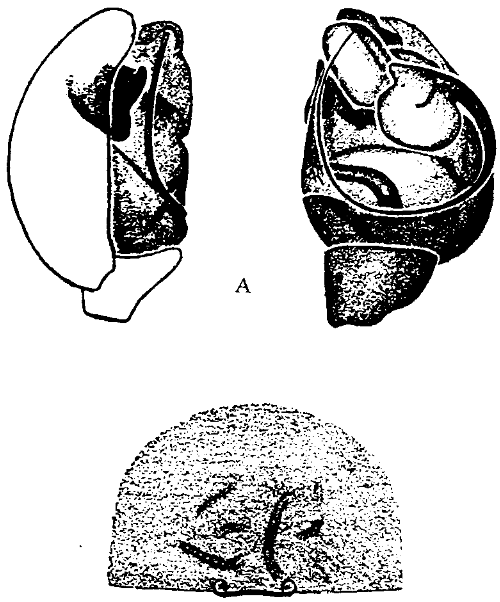
15a Males with a sclerotized area encircling pedicel from the venter onto the anterior dorsum of the abdomen, the abdomen often constricted; females with a projecting clypeus and small eyes (Fig. 30) .................. *Coleosoma acutiventer* **(Keyserling)**
15b Males without sclerotized area on abdomen; females with non-projecting clypeus and larger eyes ........... *Theridion* **spp.** 16

16a Two black spots present anterior to spinnerets ........................................................................................ *Theridion australe* **Banks**
16b Black spots absent ........................................................................................................................................................ 17



A B C D

Figure 30. *Coleosoma acutiventer* (Keyserling); A: lateral view of female, B: dorsal view of male, C: palp, D: epigynum.



A B

Figure 31. *Theridion australe* Banks; A: palp (mesal, ventral views), B: epigynum.

17a Area surrounding eyes black .................................................................................................................................................. 18
17b Area surrounding eyes not black .............................................................................................................................................. 19

18a Abdomen with scalloped marks (Fig. 32) ........................................................................................ *Theridion murarium* **Emerton**
18b Anterior of abdomen black, the rest white (Fig. 33) ................................................................... *Theridion crispulum* **Simon**

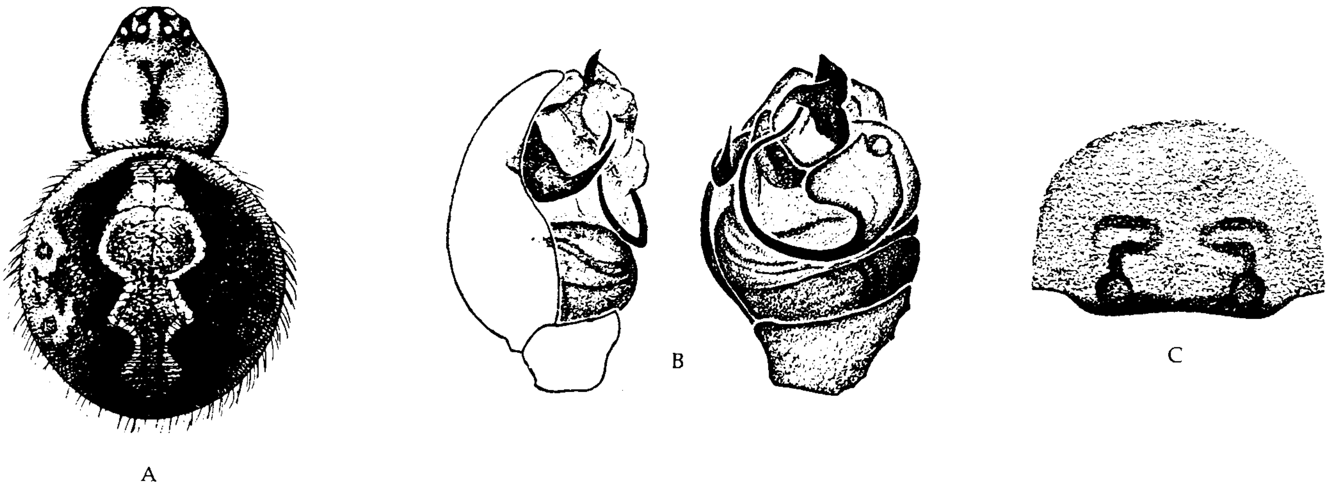



Figure 32. *Theridion murarium* Emerton; A: dorsum of male, B: palp (mesal, ventral views), C: epigynum.

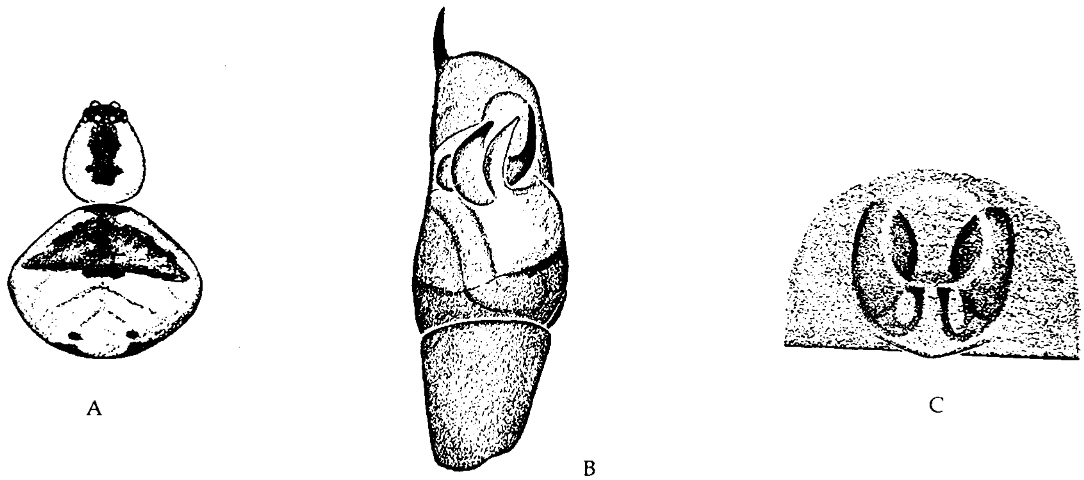



Figure 33. *Theridion crispulum* Simon; A: dorsum of female, B: palp, C: epigynum.

19a A black margin present on edge of carapace .......... *Theridion rabuni* **Chamberlin & Ivie**
19b Black margin absent .......... 20

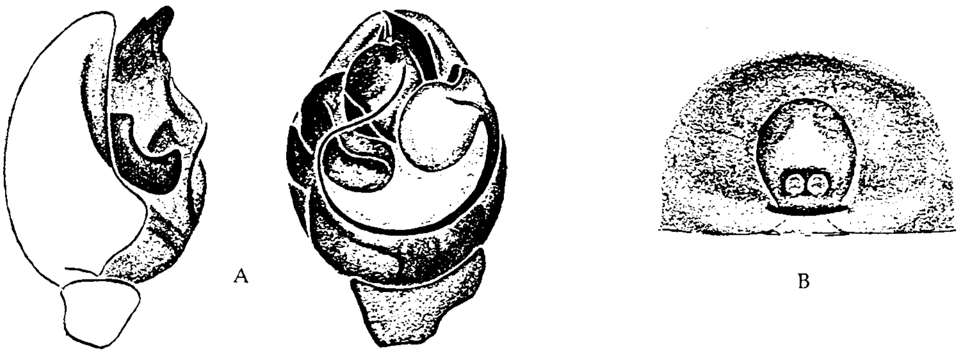



Figure 34. *Theridion rabuni* Chamberlin & Ivie; A: palp (mesal, ventral views), B: epigynum.

20a Grayish black band present on median carapace as wide as eyes but narrowing behind .......... *Theridion hidalgo* **Levi**
20b Band absent or shaped differently .......... 21

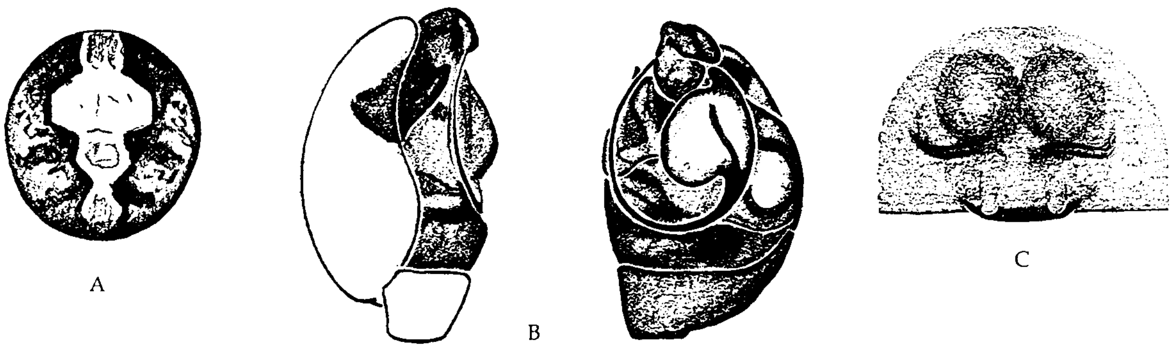



Figure 35. *Theridion hidalgo* Levi; A: abdomen of female, B: palp (mesal, ventral views), C: epigynum.

21a Median band on dorsal abdomen scalloped (Fig. 36) ........ *Theridion glaucescens* **Becker**
21b Band indistinct, abdomen white or with white spots ........ *Theridion flavonotatum* **Becker**

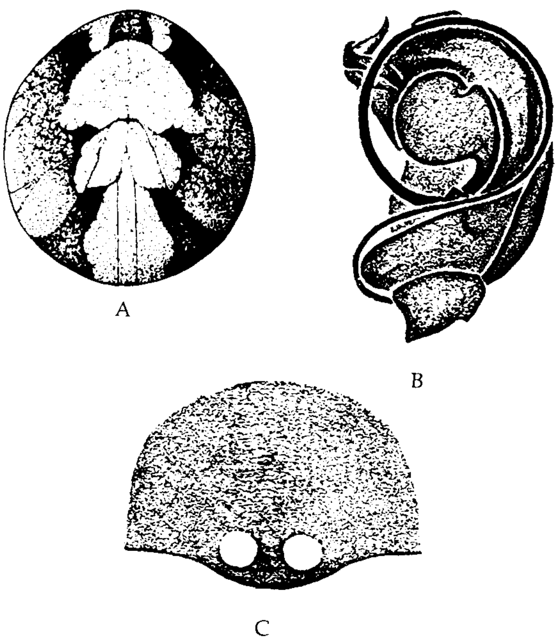


Figure 36. *Theridion glaucescens* Becker; A: abdomen, B: palp (subectal view), C: epigynum.

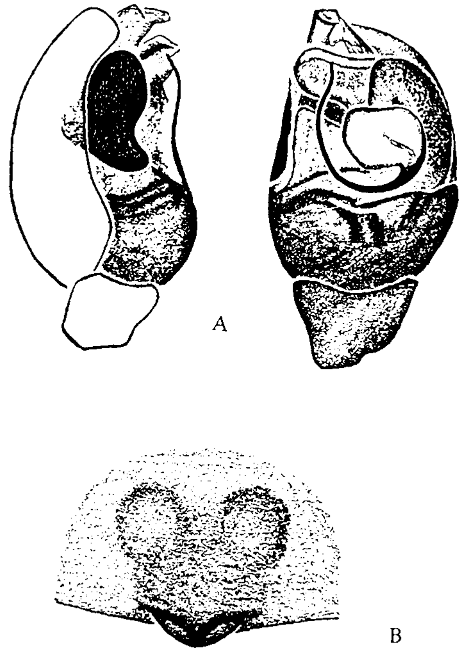


Figure 37. *Theridion flavonotatum* Becker; A: palp (mesal, ventral views), B: epigynum.

22a Tarsus with two claws present with or without tufts ........ 23
22b Tarsus with three claws present, never with tufts (third claw sometimes obscure) ........ 74

23a Eyes in three or four rows, first row on a vertical face...**Salticidae** (24 species) ........ 24
23b Eyes in two rows, or not on a vertical face ........ 44

24a Anterior eye row extremely recurved, so that eyes appear to be in four rows, body green (Fig. 38) ........ *Lyssomanes viridis* (**Walckenaer**)
24b Eyes in three rows ........ 25

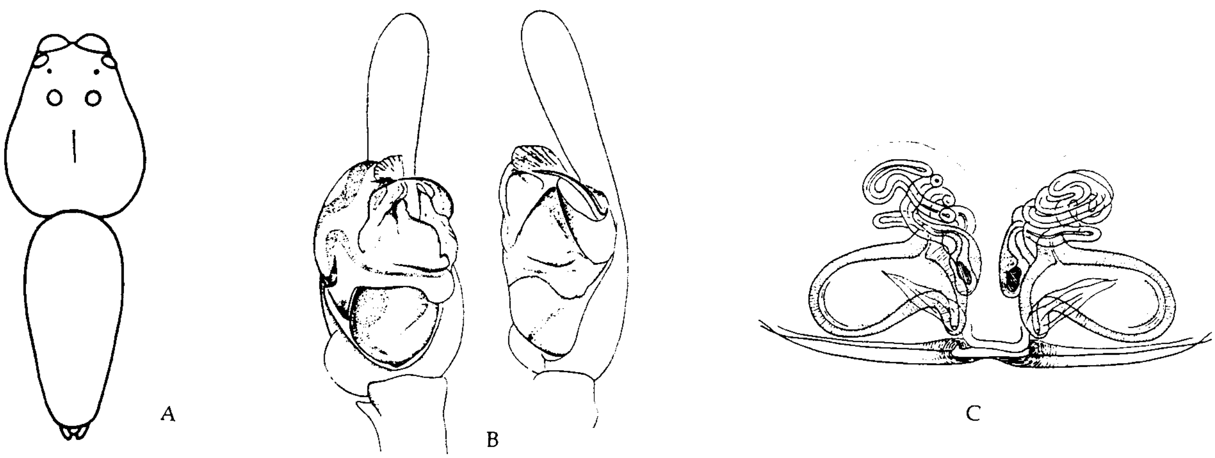


Figure 38. *Lyssomanes viridis* (Walckenaer); A: dorsum, B: palp (ventral, retrolateral views), C: epigynum (dorsal view of spermatheca).

25a Ant-like features distinct (Fig. 39) .......... *Sarinda hentzi* **(Banks)**
25b Ant-like features indistinct or absent .......... 26

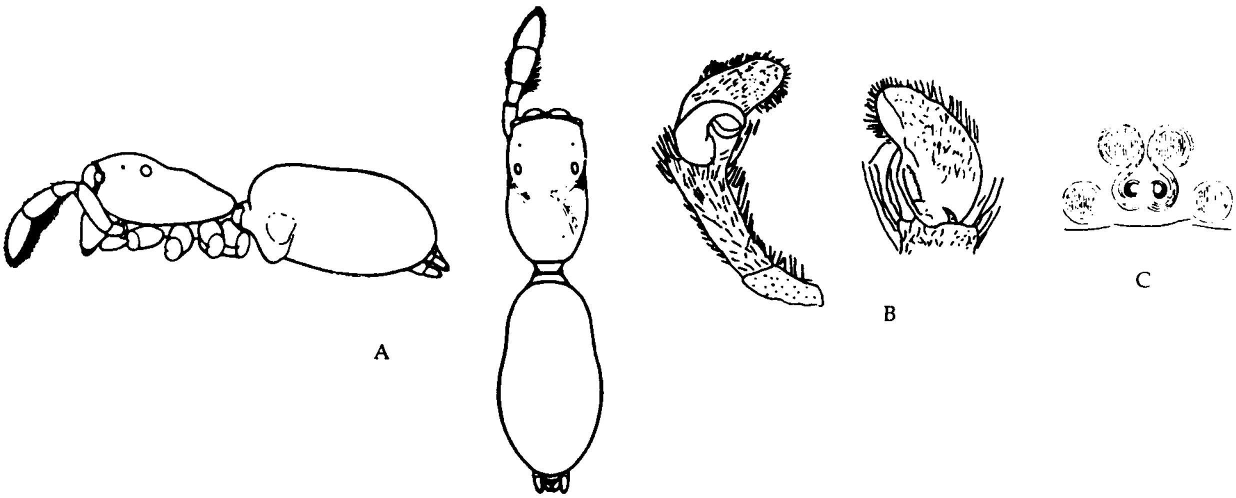



Figure 39. *Sarinda hentzi* (Banks); A: female (lateral, dorsal views), B: palp (ventral, lateral views), C: epigynum.

26a Tibia I with four bulbous hairs in a quadrangle on ventral surface .......... *Thiodina* **spp.** 27
26b Tibia I without bulbous hairs .......... 28

27a Male with a white band between PLE down the thoracic slope; female genitalia with median lateral notches (Fig. 40) .......... *Thiodina puerpera* **(Hentz)**
27b Male with an oval white spot between and just in front of PLE; female genitalia with posterior lateral notches (Fig. 41) .......... *Thiodina sylvana* **(Hentz)**

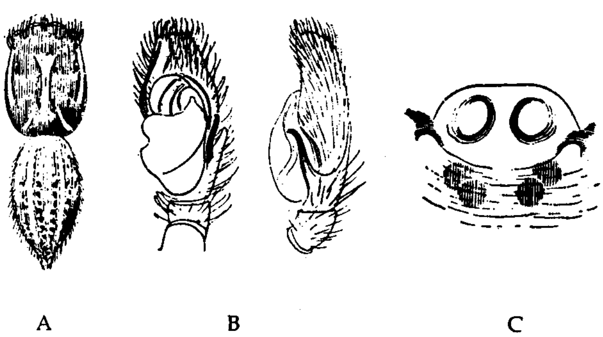



Figure 40. *Thiodina puerpera* (Hentz); A: dorsum of male, B: palp (ventral, lateral views), C: epigynum

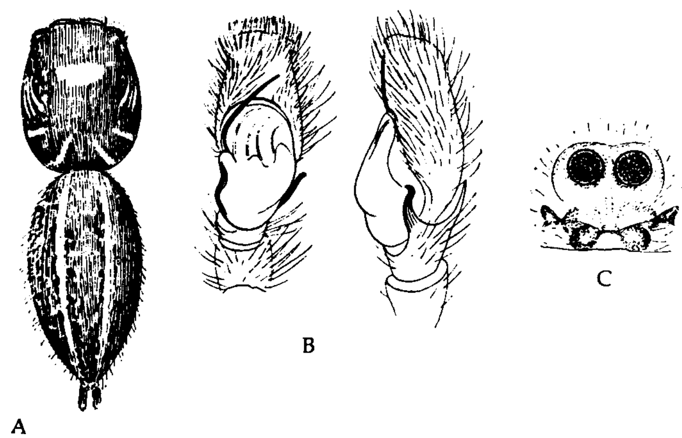



Figure 41. *Thiodina sylvana* (Hentz); A: dorsum of male, B: palp (ventral, lateral views), C: epigynum.

28a Tibia I nearly as wide as long (Fig. 42) ........................................ *Admestina tibialis* **(C. L. Koch)**
28b Tibia I much longer than wide ........................................ 29

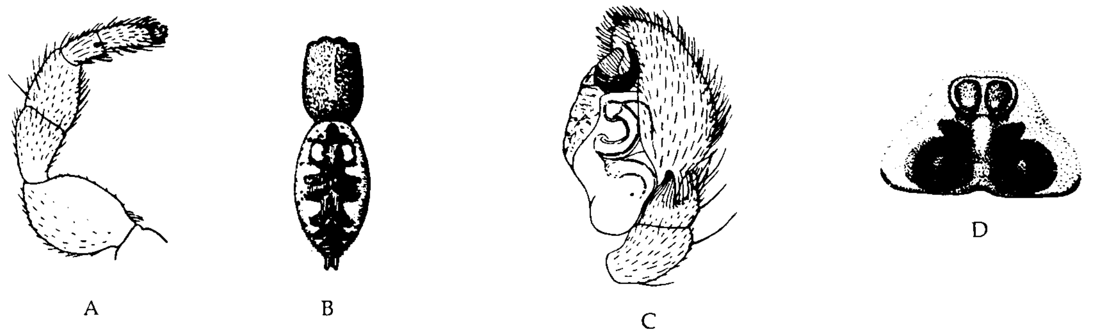



Figure 42. *Admestina tibialis* (C. L. Koch); A: prolateral view of leg I of male, B: dorsum of female, C: palp (lateral view), D: epigynum.

29a Tibia I with 4 pairs of ventral spines ........................................ 30
29b Tibia I with fewer than 4 pairs of ventral spines or none ........................................ 32

30a Carapace elongate, flattened, abdomen elongate; male with distinct abdominal markings, female abdomen pale (Fig. 43) ........................................ *Marpissa pikei* **(G. & E. Peckham)**
30b Body not elongate; markings not matching above description ........................................ 31

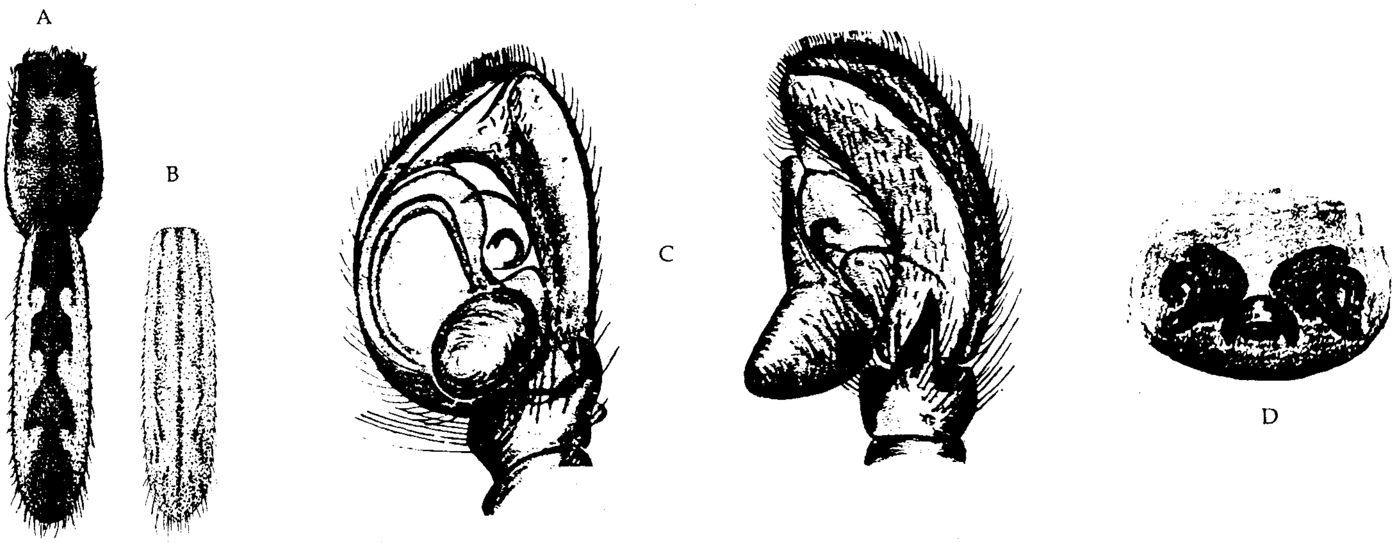



Figure 43. *Marpissa pikei* (G. & E. Peckham); A: dorsum of male, B: abdomen of female, C: palp (ventral, lateral views), D: epigynum.

31a Two white longitudinal lines running the length of the dorsal abdomen and converging at the pedicel (Fig. 44) ................ ........................................ *Marpissa lineata* (**C. L. Koch**)

31b Female with broad white longitudinal stripe; male with patches of white scales on carapace and broken band on abdomen (Fig. 45) ........................................ *Marpissa formosa* (**Banks**)

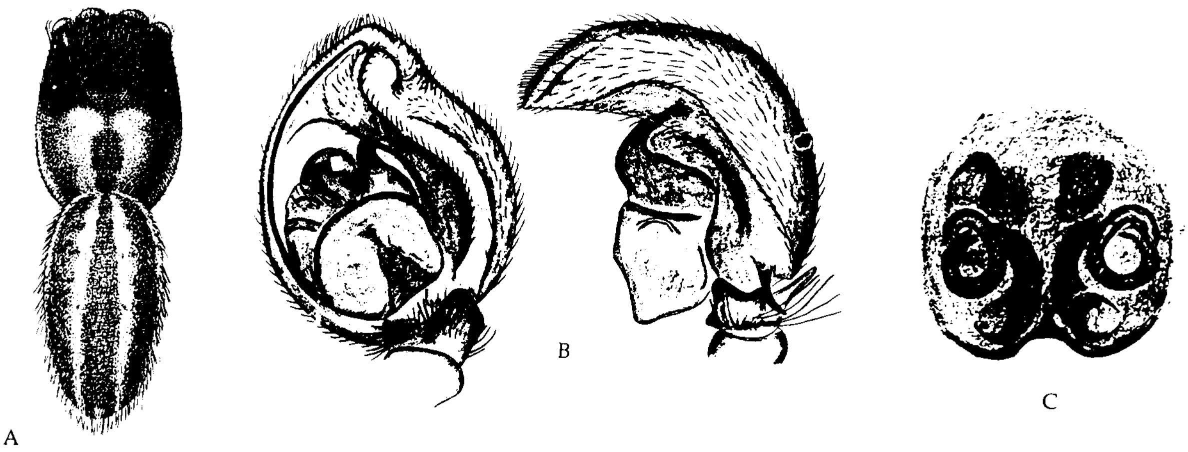



Figure 44. *Marpissa lineata* (C. L. Koch); A: dorsum, B: palp (ventral, lateral views), C: epigynum.

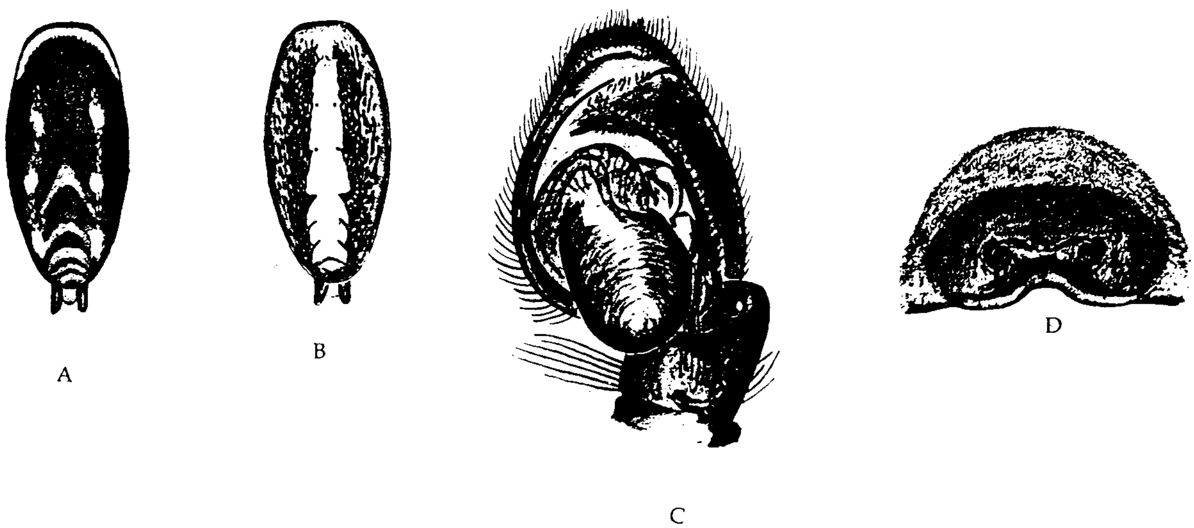



Figure 45. *Marpissa formosa* (Banks); A: abdomen of male, B: abdomen of female, C: palp, D: epigynum.

32a Tibia I possessing one ventral spine; body covered with iridescent scales (green to purple) (Fig. 46) .................................... *Agassa cyanea* **(Hentz)**
32b Tibia I with more than one spine .................................... 33

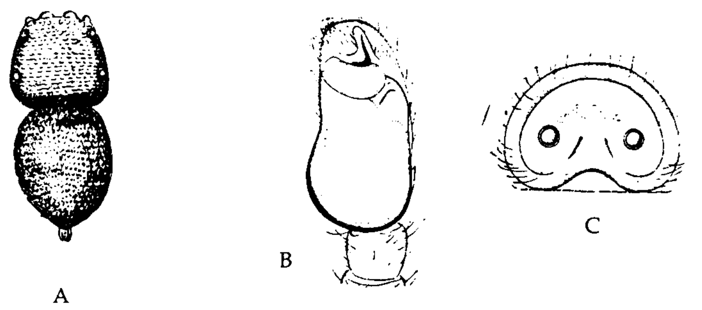
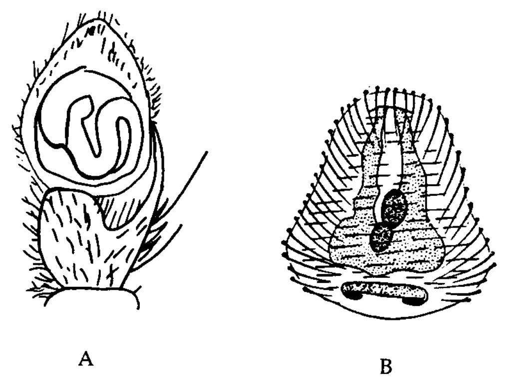



Figure 46. *Agassa cyanea* (Hentz); A: dorsum of male, B: palp, C: epigynum.

33a Cheliceral retromarginal teeth absent .................................... *Sitticus dorsatus* **(Banks)**
33b Cheliceral retromarginal tooth or teeth present .................................... 34

34a Tibia plus Patella III longer than Tibia plus Patella IV (Fig. 48) .................................... *Habronattus coecatus* **(Hentz)**
34b Tibia plus Patella III shorter than Tibia plus Patella IV .................................... 35



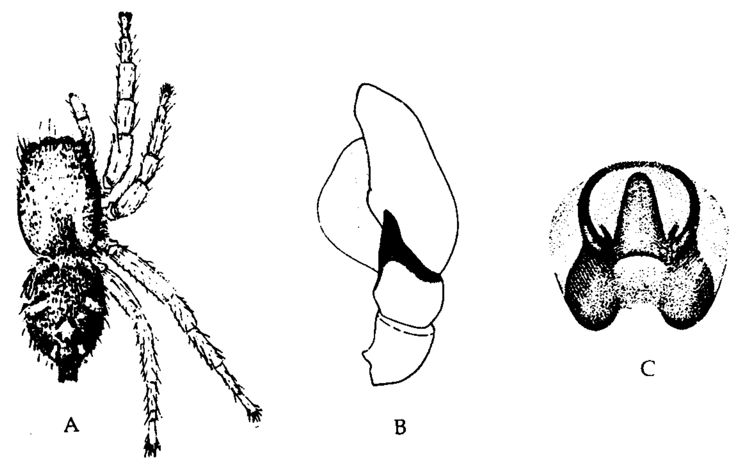




Figure 47. *Sitticus dorsatus* (Banks); A: palp, B: epigynum.

Figure 48. *Habronattus coecatus* (Hentz); A: dorsum of female, B: palp (lateral view), C: epigynum.

35a Half of carapace occupied by ocular quadrangle .......... 36
35b Less than half of carapace occupied by ocular quadrangle .......... 37

36a Carapace rounded; male lacking sharp projections on chelicerae (Fig. 49) .......... *Sassacus papenhoei* **(G. & E. Peckham)**
36b Carapace angular; males with sharp cheliceral projections .......... (Figs. 50 to 53) *Zygoballus* **spp.**

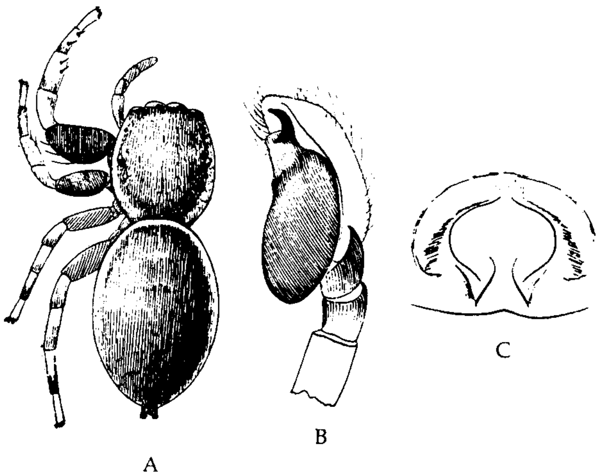



Figure 49. *Sassacus papenhoei* (G & E. Peckham); A: dorsum, B: palp (retrolateral view), C: epigynum.

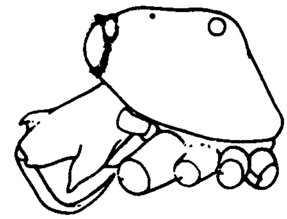


Figure 50. *Zygoballus* sp., carapace (lateral view).

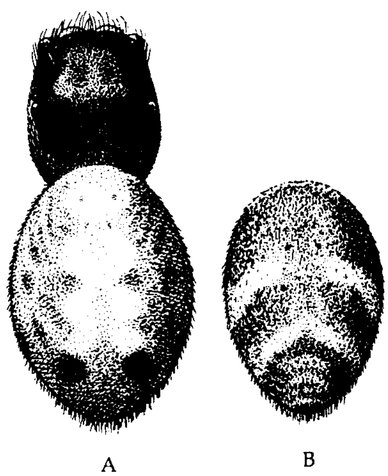



Figure 51. *Zygoballus rufipes* G & E. Peckham; A: dorsum of female, B: abdomen of male.

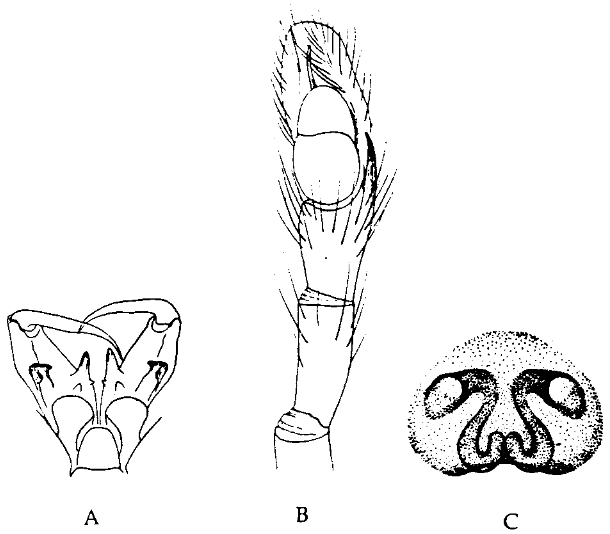



Figure 52. *Zygoballus rufipes*; A: mouthparts of male, B: palp, C: epigynum.

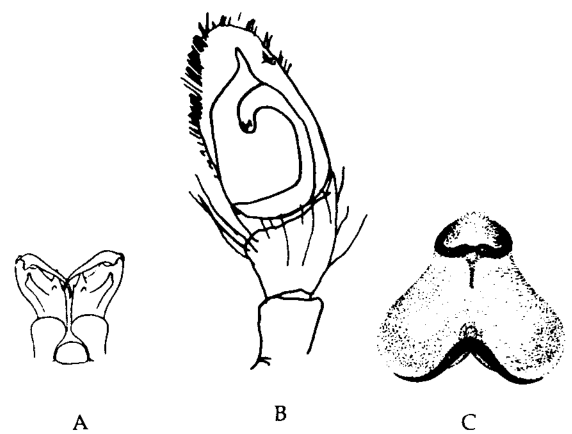



Figure 53. *Zygoballus nervosus* (G. & E. Peckham); A: mouthparts of male, B: palp, C: epigynum.

37a PME closer to ALE than to PLE ........ 38
37b PME equidistant from ALE and PLE, or closer to PLE ........ 42

38a Eye region lacking tufts of hair; chelicerae bronze in color (Fig. 54) ........ *Eris militaris* **(Hentz)**
38b Eye region typically with tufts of hair; chelicerae iridescent blue or green, rarely red brown or black ........ 39

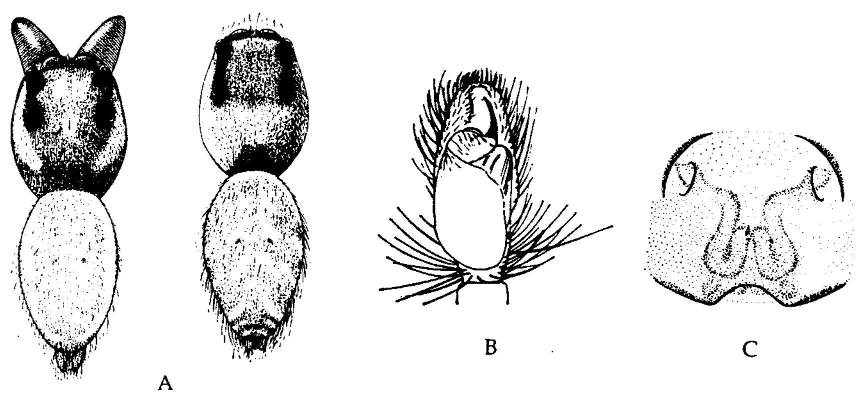



Figure 54. *Eris militaris* (Hentz); A: dorsum of male, female, B: palp, C: epigynum.

39a Dorsal aspects of carapace and abdomen mostly bright red ........................................................ *Phidippus cardinalis* **(Hentz)**
39b Dorsal carapace not red ........................................................................................................................................................... 40

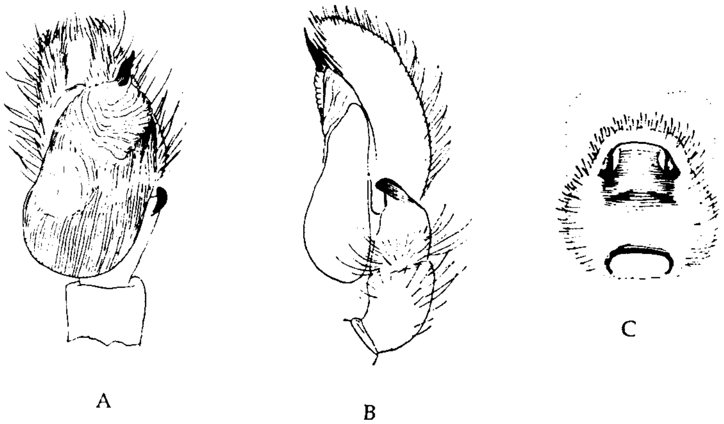



Figure 55. *Phidippus cardinalis* (Hentz); A: palp (ventral, lateral views), B: epigynum.

40a Male and female carapace black, with a prominent central abdominal white spot (may be yellow or orange) (Fig. 56) ...... ........................................................................................................................................................ *Phidippus audax* **(Hentz)**
40b Carapace and abdomen not matching the above description ........................................................................................... 41

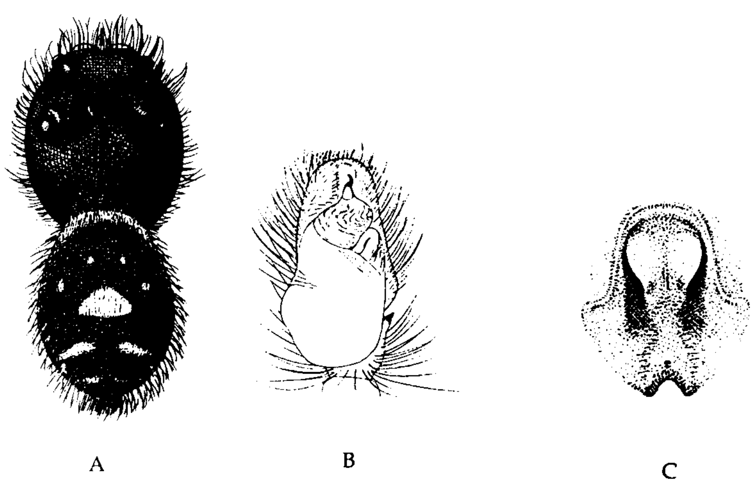



Figure 56. *Phidippus audax* (Hentz); A: dorsum, B: palp, C: epigynum.

41a Carapace of female covered with a thick layer of gray hairs; abdomen with white median stripe (Fig. 57); males black with dorsum of abdomen completely red ............ *Phidippus texanus* **Banks**

41b Gray hairs lacking; female with broad pale stripe bordered with narrow dark stripes on venter of abdomen; male dorsal abdomen red laterally and black medially (Fig. 58) ............ *Phidippus clarus* **Keyserling**

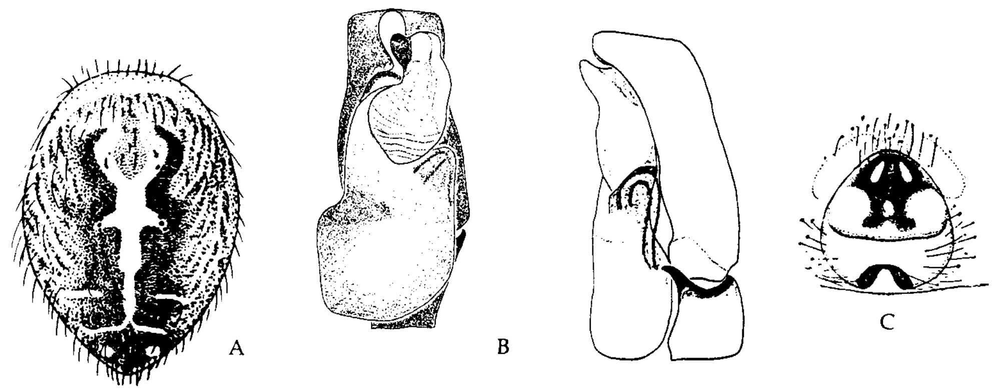



Figure 57. *Phidippus texanus* Banks; A: dorsum of abdomen, B: palp (ventral, lateral views), C: epigynum.

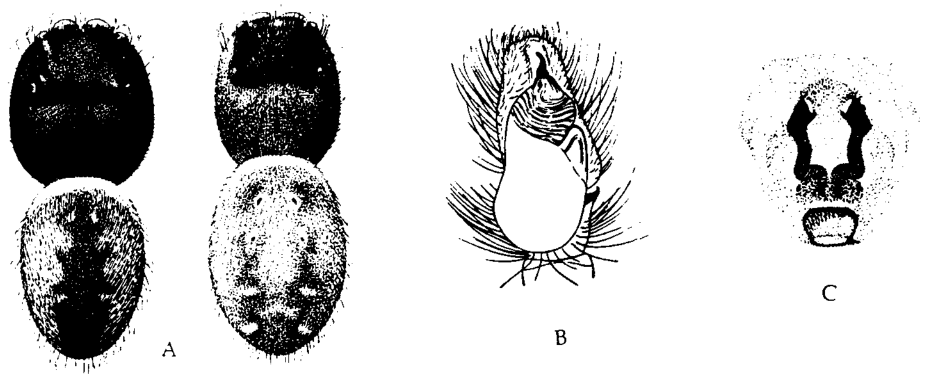



Figure 58. *Phidippus clarus* Keyserling; A: dorsum of male, female, B: palp, C: epigynum.

42a Anterior sternum narrower than labium base; legs II, III, IV white and translucent; some males with elongated forward-projecting chelicerae .......... 43
42b Anterior sternum as wide or wider than the labium base; males without forward-projecting chelicerae .......... (Figs. 59 to 61) *Metaphidippus* **spp.**

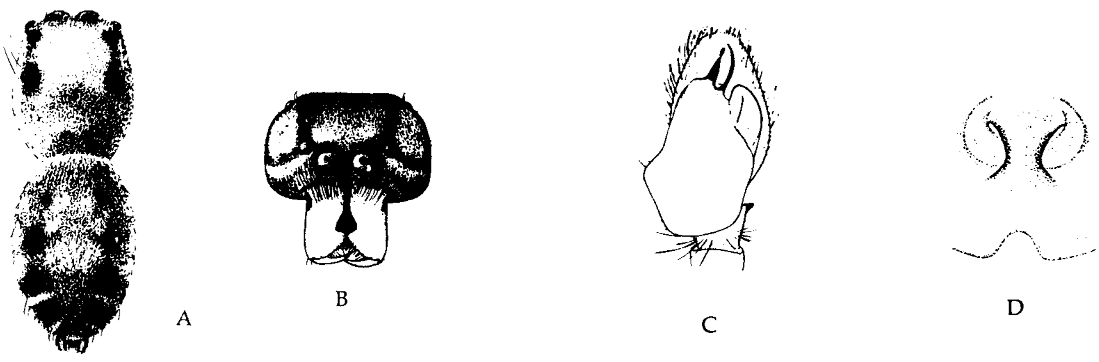



Figure 59. *Metaphidippus exiguus* (Banks); A: dorsum of female, B: face of male, C: palp, D: epigynum.

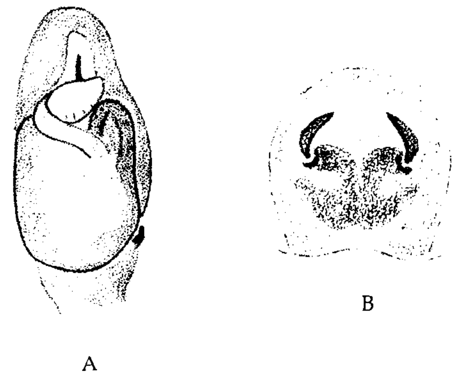



Figure 60. *Metaphidippus chera* (Chamberlin); A: palp, B: epigynum.

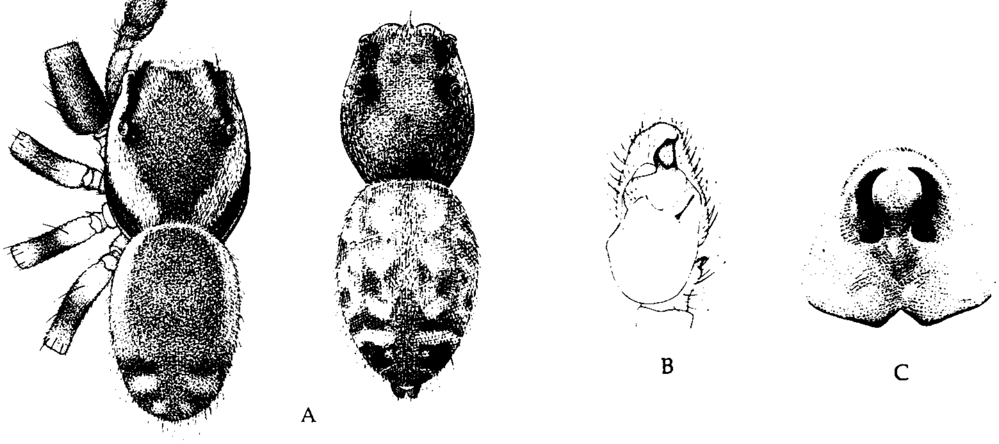



Figure 61. *Metaphidippus galathea* (Walckenaer); A: dorsum of male, female, B: palp, C: epigynum.

43a Leg I of male brown with white tarsus; female dorsal abdomen yellow to brown with brown spots and chevrons posteriorly (Fig. 62) ........ *Hentzia palmarum* **(Hentz)**

43b Leg I of male white; female dorsal abdomen white with three pairs of dark spots ........ *Hentzia mitrata* **(Hentz)**

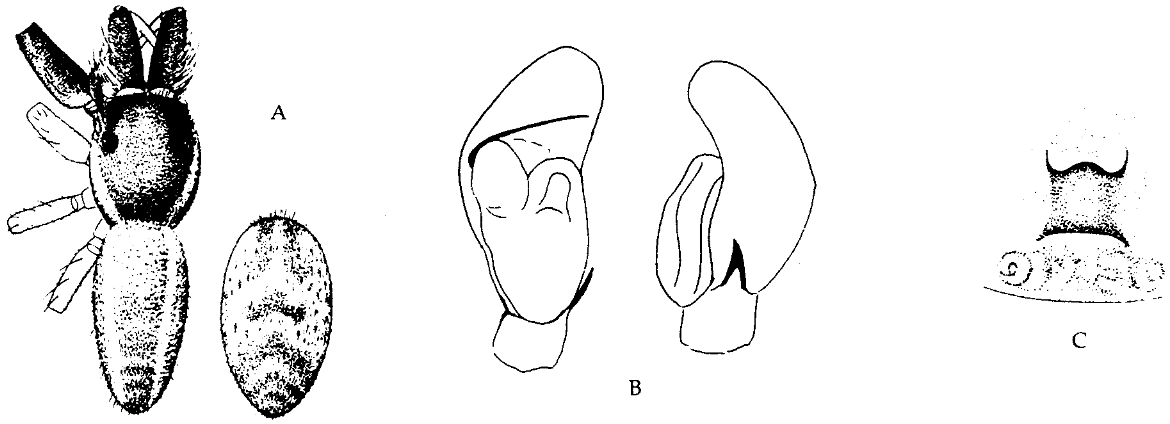



Figure 62. *Hentzia palmarum* (Hentz); A: dorsum of male, abdomen of female, B: palp (ventral, retrolateral views), C: epigynum.

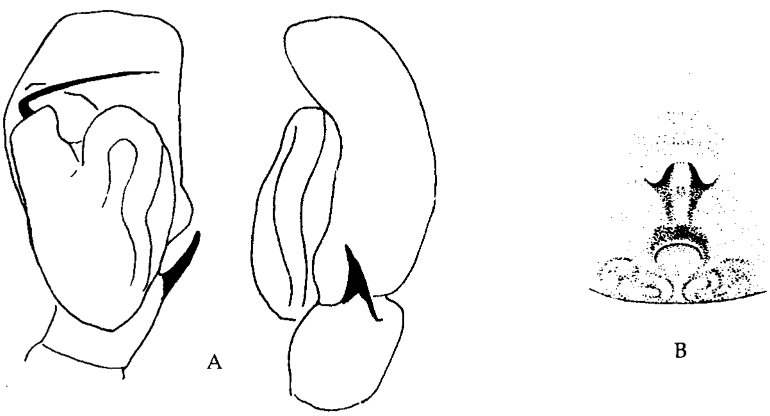



Figure 63. *Hentzia mitrata* (Hentz); A: palp (ventral, retrolateral views), B: epigynum.

44a Ventral abdominal tracheal opening (Fig. 64B) advanced forward at least to middle of abdomen... **Anyphaenidae** (3 species) ........ 45

44b Ventral abdominal tracheal opening nearer to spinnerets than to epigastric furrow ........ 47

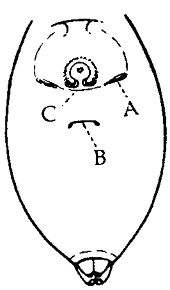



Figure 64. A: book lung opening of *Aysha*, B: spiracle, C: epigastric furrow.

45a AME approximately the same size as PME; ventral tracheal opening much nearer to the epigastric furrow than to spinnerets (Fig. 64B) ........ *Aysha gracilis* **(Hentz)**

45b AME smaller than PME; ventral tracheal furrow midway between the base of the spinnerets and the epigastric furrow ........ 46

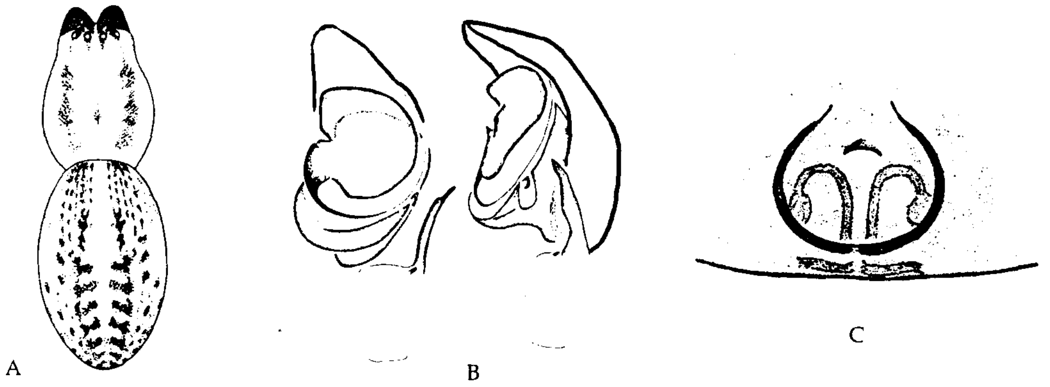



Figure 65. *Aysha gracilis* (Hentz); A: dorsum of female, B: palp (ventral, retrolateral views), C: epigynum.

46a Tibia I 1 1/2 times as long as carapace ........ *Wulfila saltabundus* **(Hentz)**

46b Tibia not longer or barely longer than carapace ........ *Teudis mordax* **(O.P.-Cambridge)**

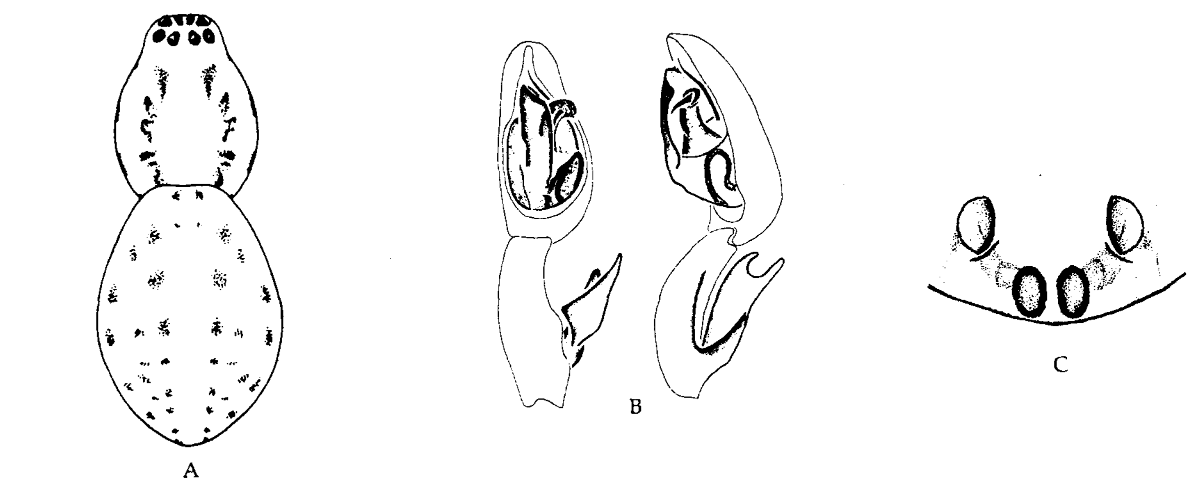



Figure 66. *Wulfila saltabundus* (Hentz); A: dorsum of female, B: palp (ventral, retrolateral views), C: epigynum.

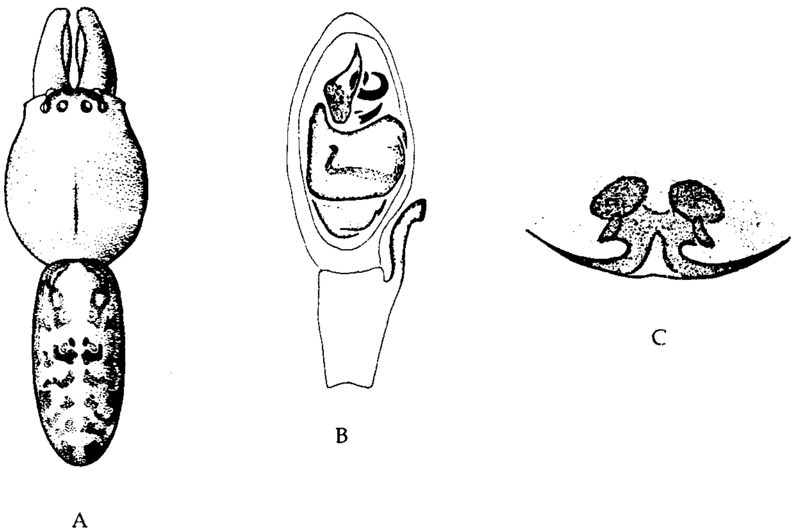



Figure 67. *Teudis mordax* (O.P.-Cambridge); A: dorsum of male, B: palp, C: epigynum.

47a Legs directed laterally, at least legs I and II laterigrade, i. e., turned so the prolateral surface appears dorsal, crab-like .. 48
47b Legs prograde .......... 57

48a Claw tufts and scopula present (Fig. 68); colulus absent...**Philodromidae** (4 species) .......... 49
48b Claw tufts lacking; scopula present or absent; colulus present (Fig. 69)...**Thomisidae** (12 species) .......... 52

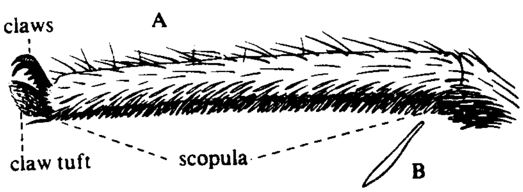



Figure 68. A: Scopula and claw tufts; B: spatulate hair.

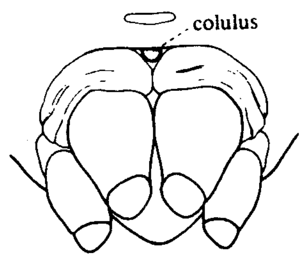



Figure 69. Spinnerets showing colulus.

49a Leg II at least twice as long as other legs (Fig. 70) .......... *Ebo punctatus* **Sauer & Platnick**
49b Leg II not longer than leg I .......... 50

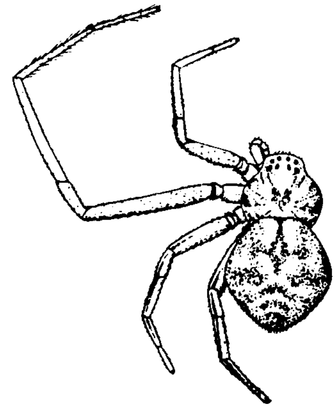


Figure 70. *Ebo* sp. female; proportional differentiation of legs.

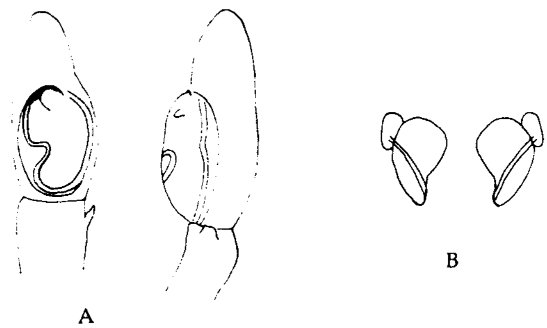



Figure 71. *Ebo punctatus* Sauer & Platnick; A: palp (ventral, retrolateral views), B: epigynum.

50a Posterior median eyes distinctly farther from each other than from the lateral eyes (Fig. 72) ........................................................ *Philodromus pratariae* **(Scheffer)**

50b Posterior eyes equidistant or median eyes farther from lateral eyes than from each other ........................................................ 51

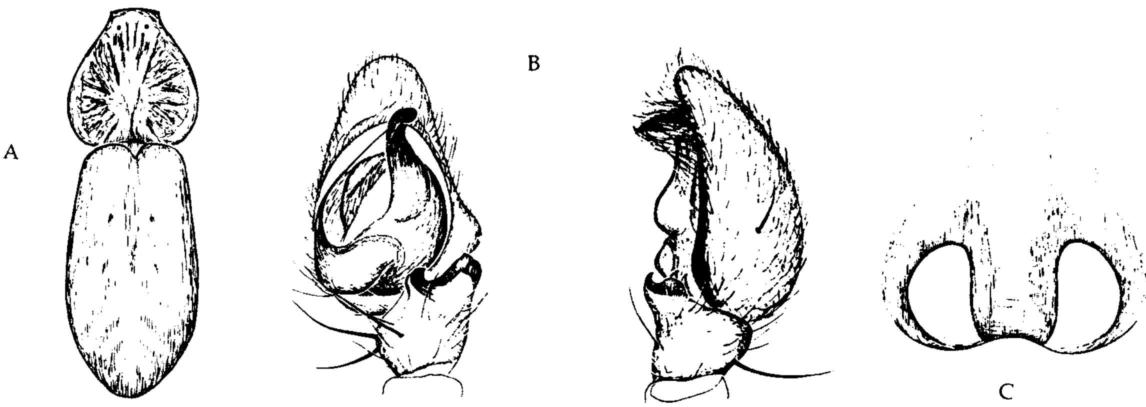



Figure 72. *Philodromus pratariae* (Scheffer); A: dorsum of female, B: palp (ventral, retrolateral views), C: epigynum.

51a Carapace almost as wide as long, abdomen $1\frac{1}{4}$ to $1\frac{3}{4}$ as long as wide (Fig. 73) ........ *Thanatus formicinus* **(Clerck)**
51b Carapace not greater than $\frac{4}{5}$ as wide as long; abdomen from $2\frac{1}{2}$ to 5 times as long as wide ........ *Tibellus duttoni* **(Hentz)**

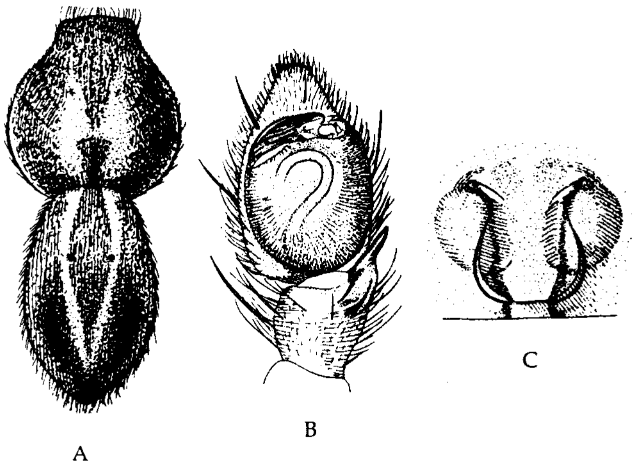



Figure 73. *Thanatus formicinus* (Clerck); A: dorsum, B: palp, C: epigynum

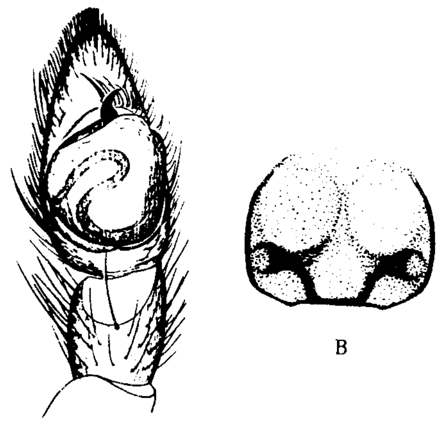



Figure 74. *Tibellus duttoni* (Hentz); A: palp, B: epigynum.

52a Clypeus strongly sloping; abdomen high and sloping upward to the posterior tubercle (Fig. 75) ........ *Tmarus* **sp.**
52b Clypeus vertical; abdomen flattened and broadly rounded posteriorly without a tubercle ........ 53

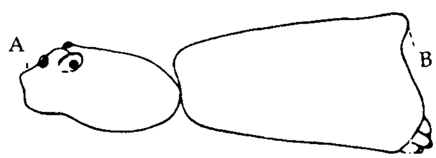



Figure 75. *Tmarus* sp. (lateral view); A: sloping clypeus, B: tubercle.

53a Tubercles of lateral eyes joined together ........ 54
53b Tubercles of lateral eyes separated, discrete ........ 56

54a ALE larger than AME ........ 55
54b Anterior row of eyes about equal in size; a distinct white carina present on clypeus (Figs. 76, 77) ........ *Misumenoides formosipes* **(Walckenaer)**

Figure 76. Carina of *Misumenoides formosipes* (Walckenaer).

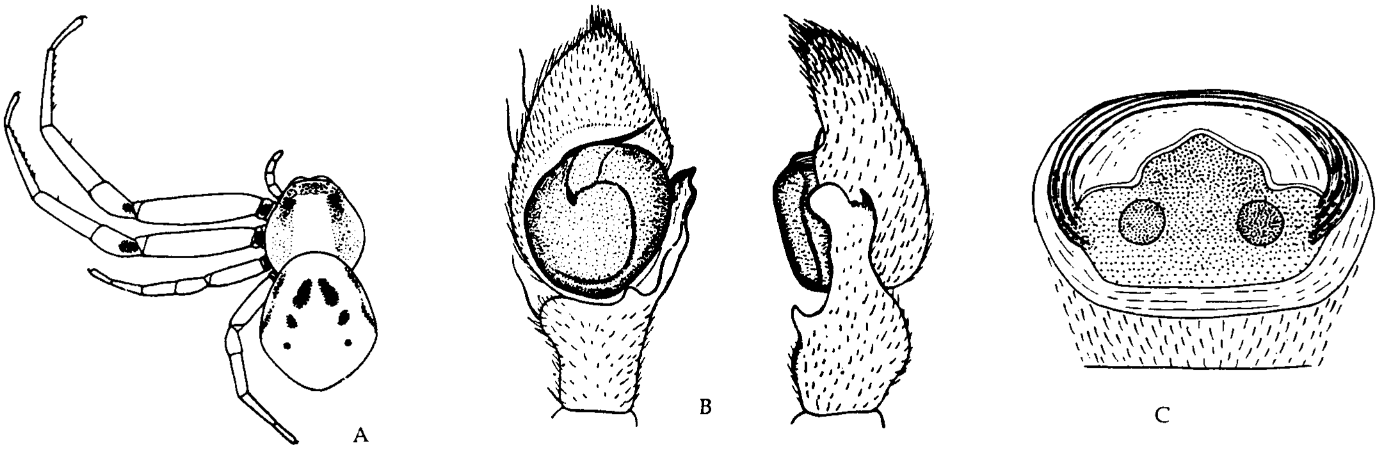



Figure 77. *Misumenoides formosipes* (Walckenaer); A: dorsum of female, B: palp (ventral, retrolateral views), C: epigynum.

55a Carapace nearly devoid of spines (Fig. 78) ........ *Misumenops oblongus* **(Keyserling)**
55b Carapace with numerous spines ........ (Figs. 79 to 82) (other *Misumenops* **spp.**)

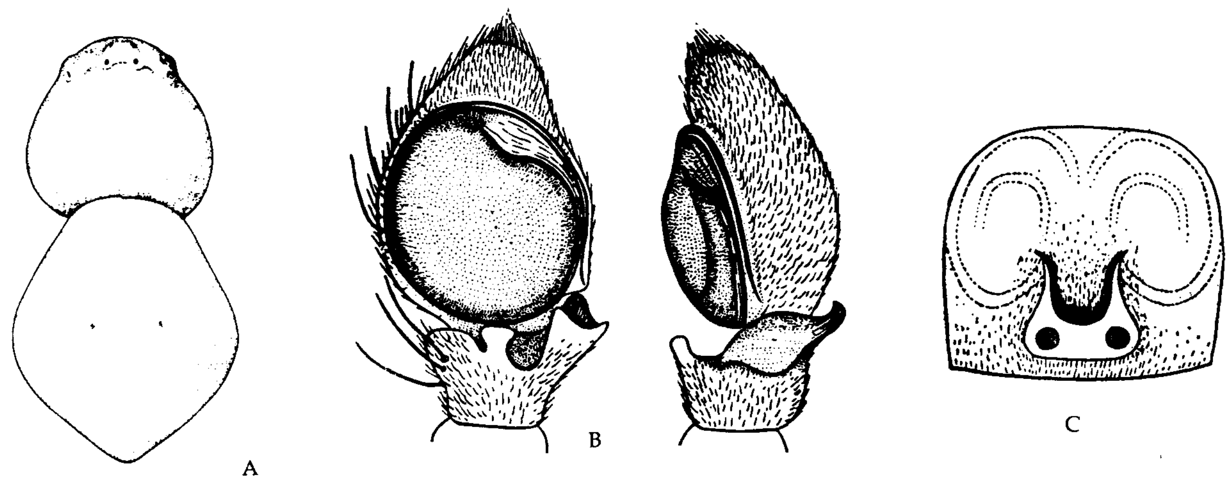



Figure 78. *Misumenops oblongus* (Keyserling); A: dorsum, B: palp (ventral, retrolateral views), C: epigynum.

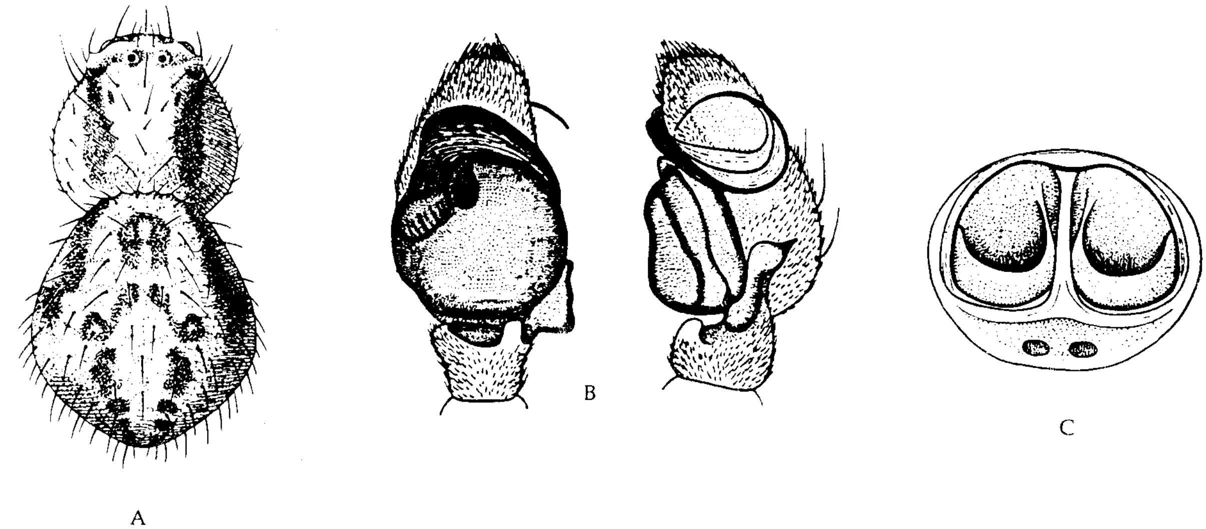



Figure 79. *Misumenops asperatus* (Hentz); A: dorsum of female, B: palp (ventral, retrolateral views), C: epigynum.

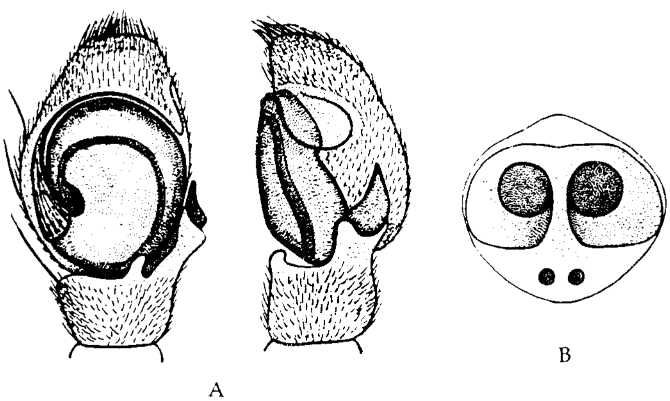



Figure 80. *Misumenops celer* (Hentz); A: palp (ventral, retrolateral views), B: epigynum.

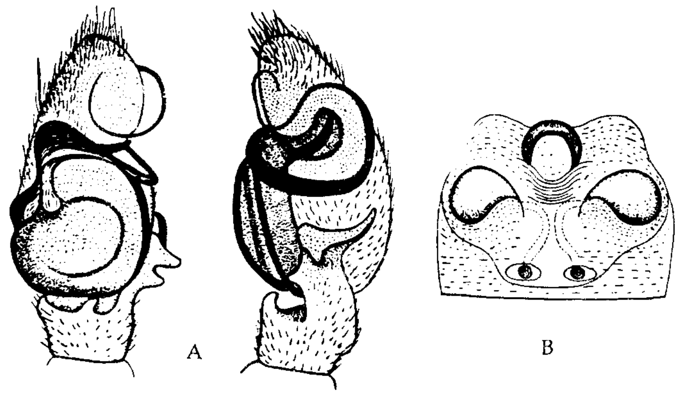



Figure 81. *Misumenops coloradensis* Gertsch; A: palp (ventral, retrolateral views), B: epigynum.

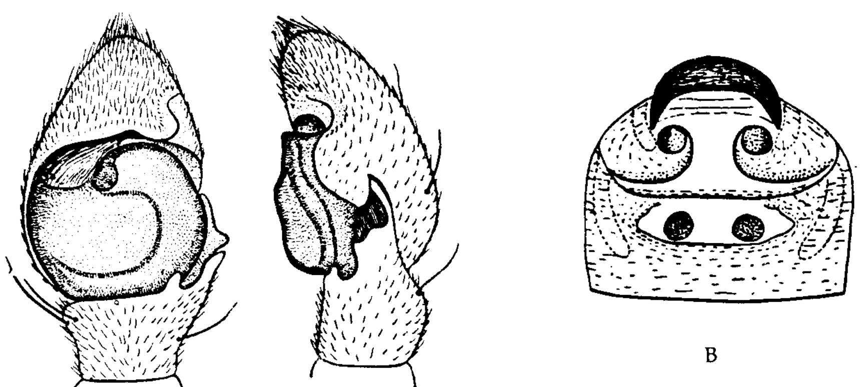



Figure 82. *Misumenops dubius* (Keyserling); A: palp (ventral, retrolateral views), B: epigynum.

56a Carapace strongly convex, tarsus I with 7 to 12 teeth on claw ....................................................(Fig. 83) *Synema parvula* (**Hentz**)
56b Carapace less convex; claws on tarsus I with fewer than 7 teeth ......................................................(Figs. 84 to 87) *Xysticus* **spp.**

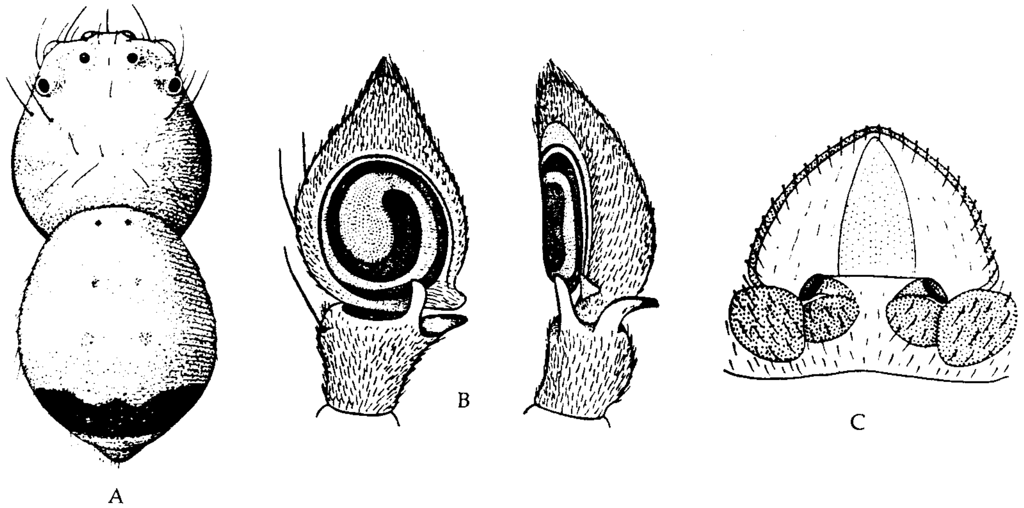



Figure 83. *Synema parvula* (Hentz); A: dorsum, B: palp (ventral, retrolateral views), C: epigynum.

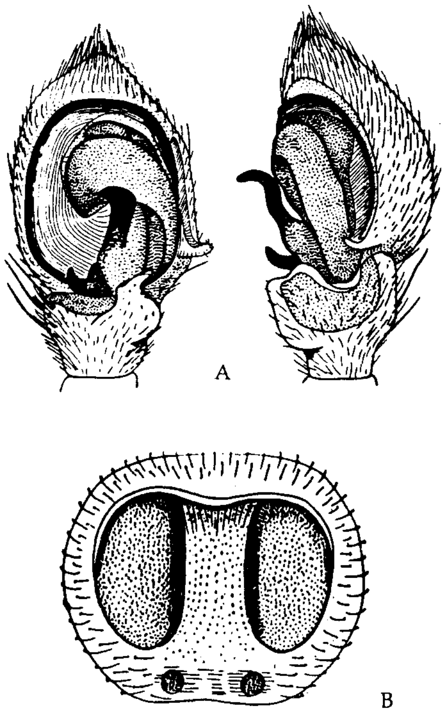



Figure 84. *Xysticus auctificus* Keyserling; A: palp (ventral, retrolateral views), B: epigynum.

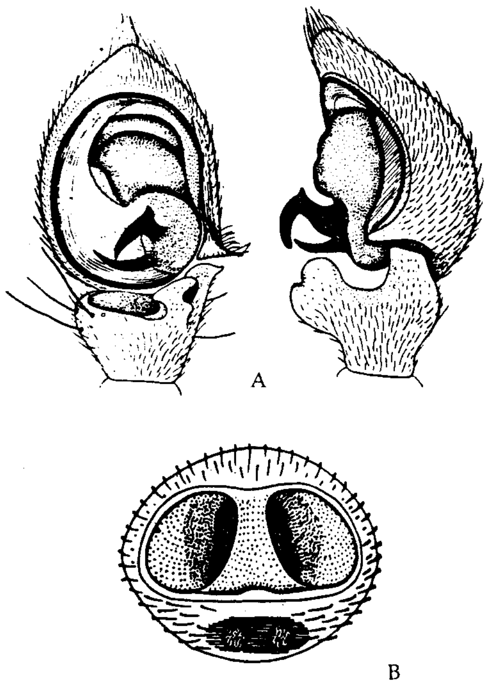



Figure 85. *Xysticus texanus* Banks; A: palp (ventral, retrolateral views), B: epigynum.

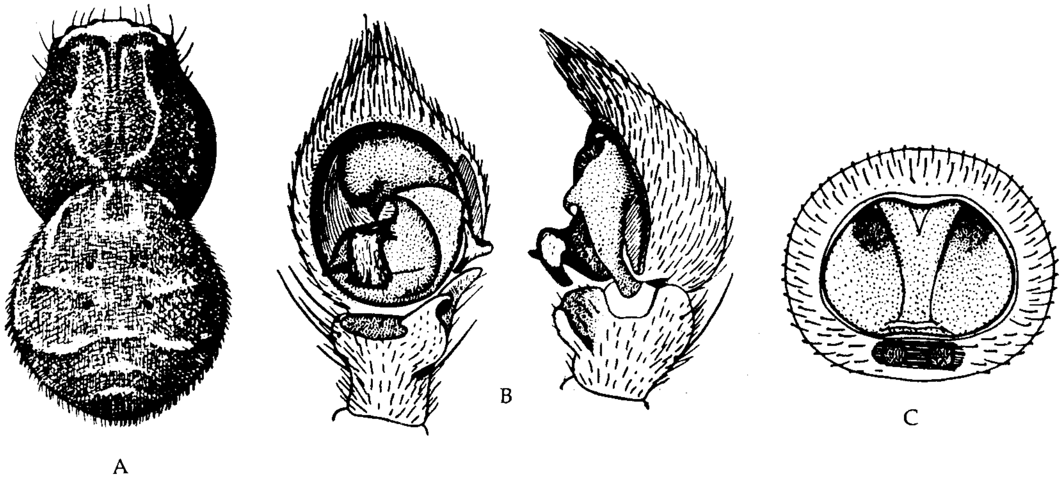



Figure 86. *Xysticus elegans* Keyserling; A: dorsum, B: palp (ventral, retrolateral views), C: epigynum.

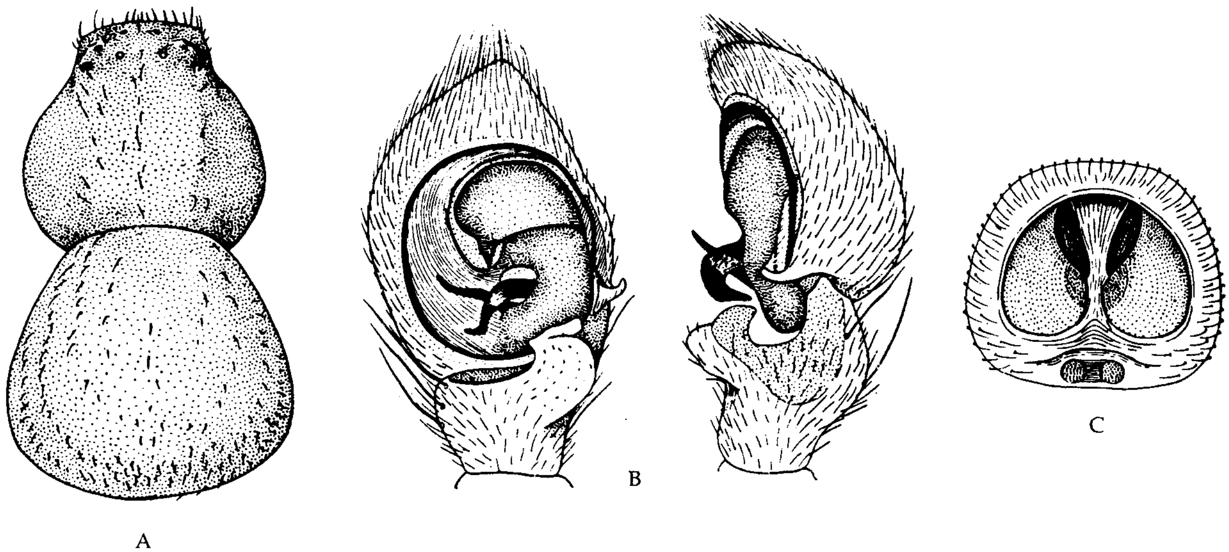



Figure 87. *Xysticus funestus* Keyserling; A: dorsum, B: palp (ventral, retrolateral views), C: epigynum.

57a Distal segment of posterior spinnerets cylindrical and nearly as long as the basal segment...**Miturgidae** (1 species) ........... ........................................................................ *Teminius affinis* **Banks**

57b Distal segment of posterior spinnerets shorter, not cylindrical or much shorter than basal segment ...................................58

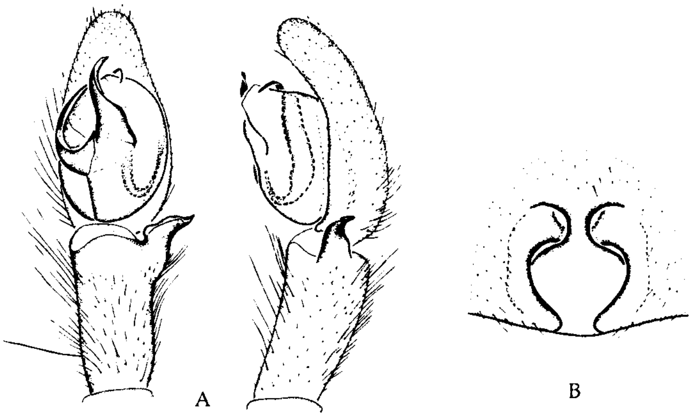



Figure 88. *Teminius affinis* Banks; A: palp (ventral, retrolateral views), B: epigynum.

58a Eyes homogeneous, PME circular; spinnerets conical (Fig. 89)...**Clubionidae** (8 species) ........................................ 59
58b Eyes heterogeneous, AME dark, PME triangular or elliptical; anterior spinnerets cylindrical (Fig. 90)...**Gnaphosidae** (11 species) ........................................ 66

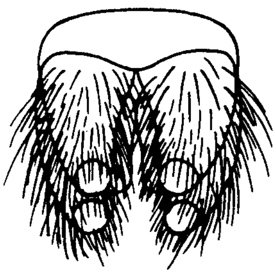


Figure 89. Conical spinnerets of *Clubiona*.

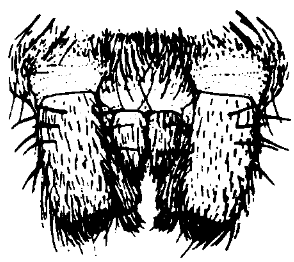


Figure 90. Spinnerets of *Gnaphosa*.

59a Tibia I with 5 to 8 pairs of spines ventrally or 2 dense rows of spines; body with iridescent scales (Fig. 91) ........................................ (Liocraninae) ***Phrurotimpus* spp.**
59b Tibia I with 0 to 3 pairs of ventral tibial spines (Corinninae and Clubioninae) ........................................ 60

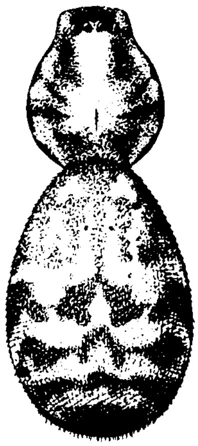


Figure 91. Dorsum of *Phrurotimpus* sp.

60a Wide longitudinal band of bright-orange hairs on dorsum of abdomen present (Fig. 92) ............ *Castianeira crocata* **(Hentz)**
60b Wide longitudinal band on abdomen absent ............ 61

61a Abdomen with dorsal sclerite ............ 62
61b Abdomen without dorsal sclerite ............ 63

62a Two white bands traversing dorsal abdomen or 2 spots; abdomen darkens toward the posterior (Fig. 93) ............ *Castianeira gertschi* **Kaston**
62b More than 2 traverse bands or spots (Fig. 94) ............ *Castianeira longipalpus* **(Hentz)**

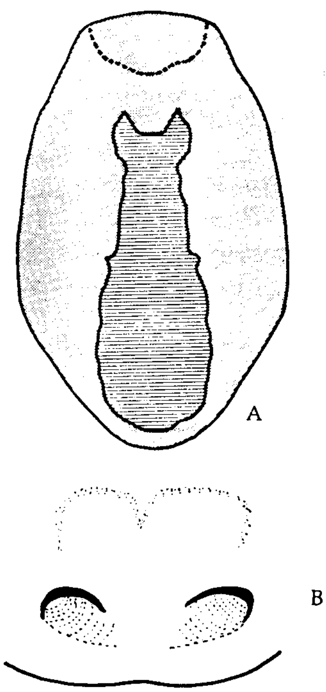



Figure 92. *Castianeira crocata* (Hentz); A: abdomen of female, B: epigynum.

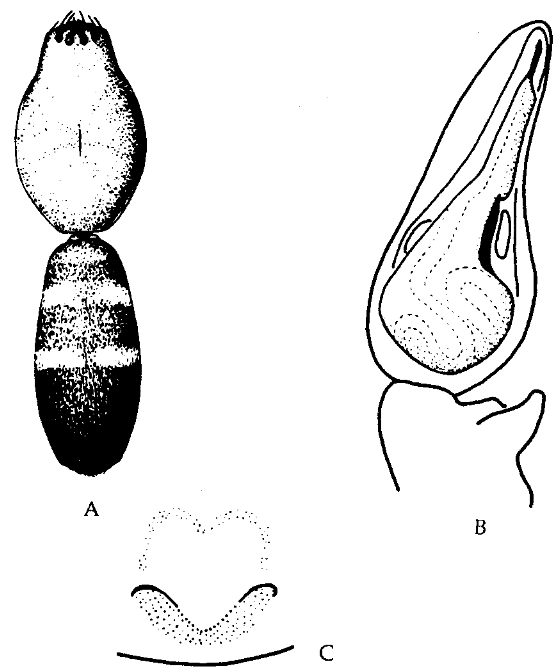



Figure 93. *Castianeira gertschi* Kaston; A: dorsum of male, B: palp, C: epigynum.

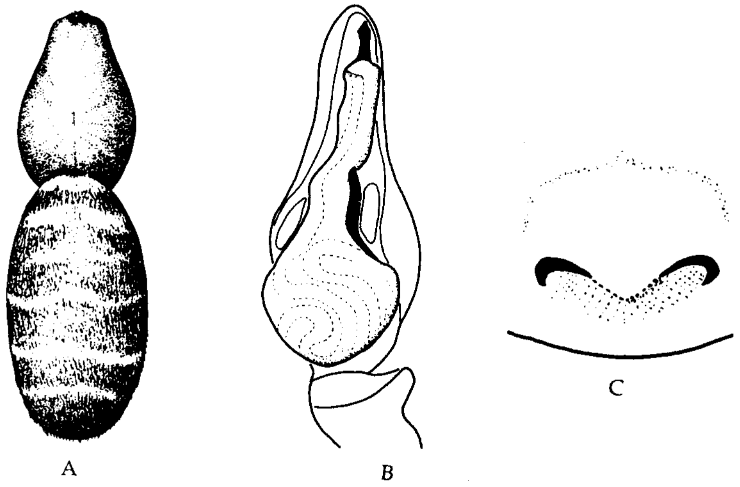



Figure 94. *Castianeira longipalpus* (Hentz); A: dorsum, B: palp, C: epigynum.

63a Tibia I without ventral spines; dark carapace (Fig. 95) ........ *Trachelas* **spp.** 64
63b Tibia I with 1 or 2 pairs of ventral spines ........ (Clubioninae) 65

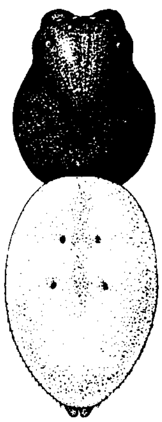


Figure 95. Dorsum of *Trachelas* spp.

64a Posterior row of eyes straight, not recurved, 3.1 to 4.1 mm ........ *Trachelas deceptus* **(Banks)**
64b Posterior row of eyes recurved, 4.8 to 7.3 mm ........ *Trachelas volutus* **Gertsch**

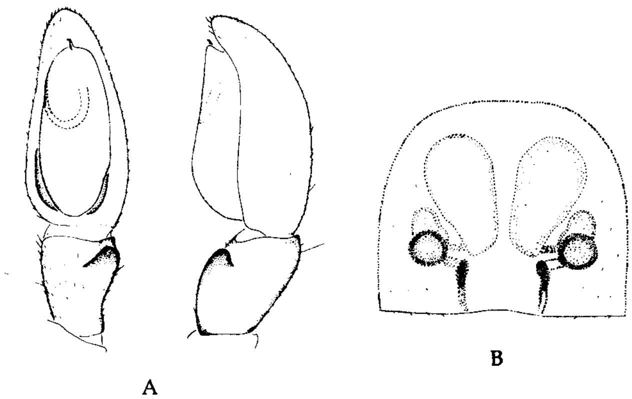



**Figure 96. *Trachelas deceptus* (Banks); A: palp (ventral, retrolateral views), B: epigynum.**

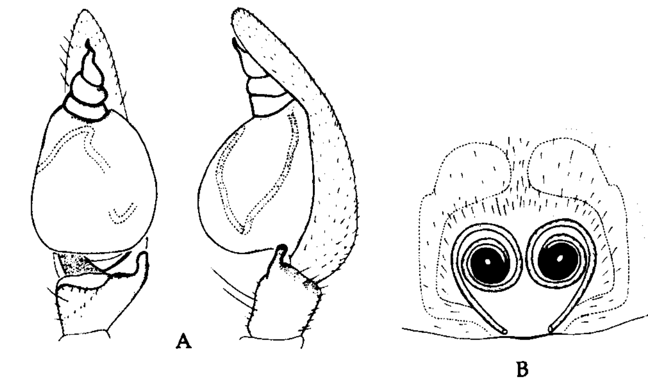



**Figure 97. *Trachelas volutus* Gertsch; A: palp (ventral, retrolateral views), B: epigynum.**

65a Trochanters notched or at least III and IV notched ........ *Cheiracanthium inclusum* **(Hentz)**
65b Trochanters III and IV not notched or only IV with a notch; claw tufts well developed (Fig. 100) ........ *Clubiona abboti* **L. Koch**

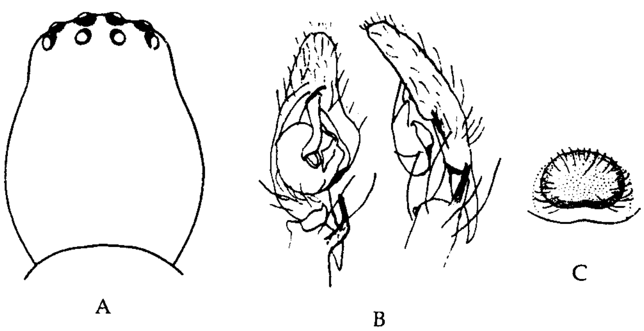



Figure 98. *Cheiracanthium inclusum* (Hentz); A: carapace, B: palp (ventral, lateral views), C: epigynum.

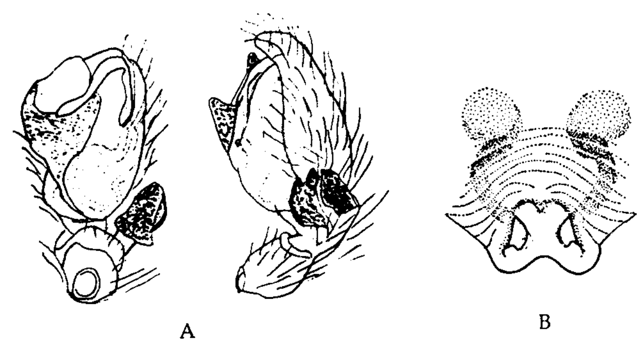



Figure 99. *Clubiona abboti* L. Koch; A: palp (ventral, retrolateral views), B: epigynum.

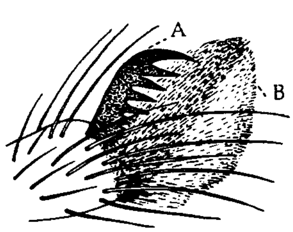



Figure 100. Claw tufts of *Clubiona*; A: claw, B: tufts.

66a Spinnerets contiguous ........................................ 67
66b Spinnerets well separated ........................................ 69

67a Two white bands on abdomen; genitalia as in Figure 101 ........................................ *Micaria longipes* **Emerton**
67b Bands absent ........................................ 68

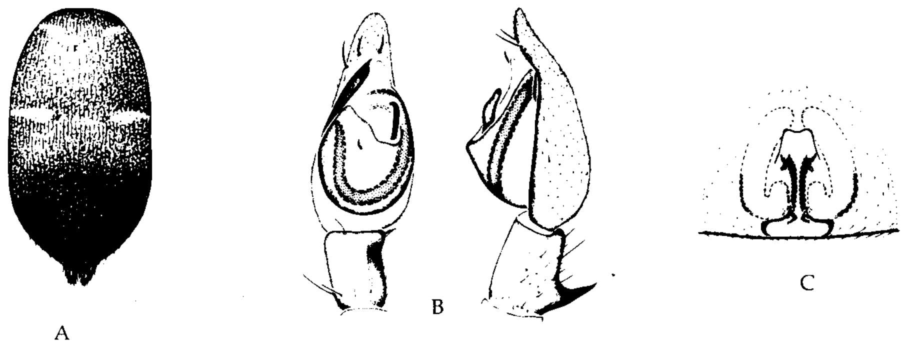



Figure 101. *Micaria longipes* Emerton; A: abdomen of female, B: palp (ventral, retrolateral views), C: epigynum.

68a Abdomen light in color ........................................ *Micaria vinnula* **Gertsch & Davis**
68b Abdomen dark, shiny with 1 incomplete band; genitalia as in Figure 103 ........................................ *Micaria deserticola* **Gertsch**

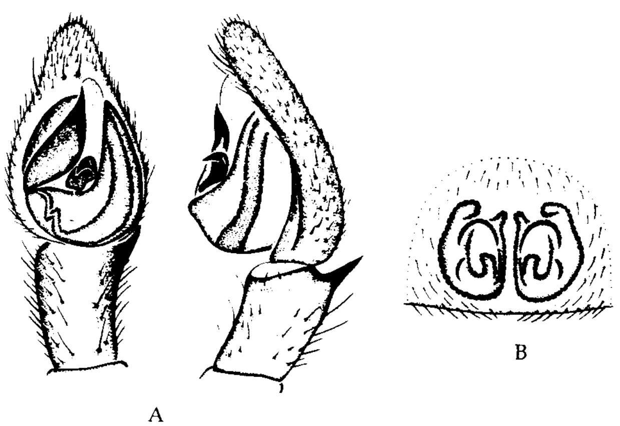



Figure 102. *Micaria vinnula* Gertsch & Davis; A: palp (ventral, retrolateral views), B: epigynum.

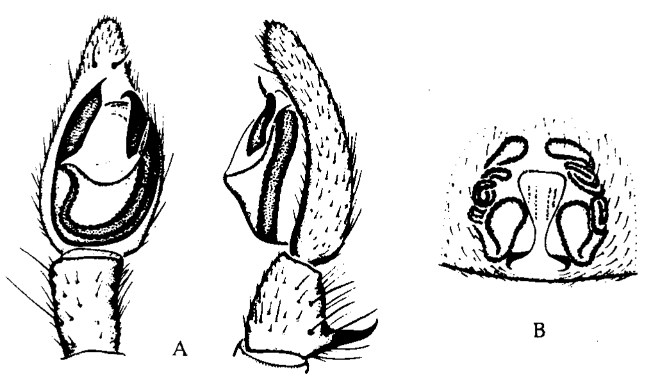



Figure 103. *Micaria deserticola* Gertsch; A: palp (ventral, retrolateral views), B: epigynum.

69a Distal preening comb present on venter of metatarsi III and IV (Fig. 104) ................................ (Figs. 105, 106) *Drassyllus* **spp.**
69b Distal preening comb absent on venter of metatarsi III and IV ........................................................................................................ 70

Figure 104. Preening comb, metatarsus III and IV.

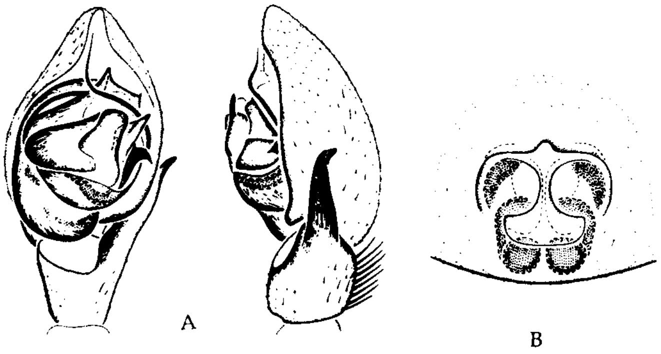



Figure 105. *Drassyllus inanus* Chamberlin & Gertsch; A: palp (ventral, retrolateral views), B: epigynum.

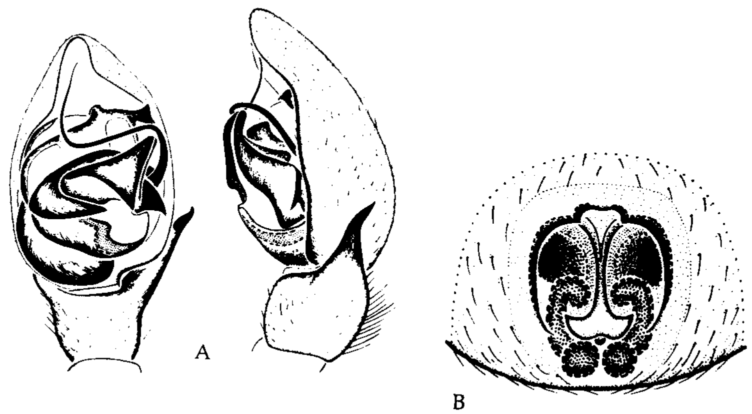



Figure 106. *Drassyllus notonus* Chamberlin; A: palp (ventral, retrolateral views), B: epigynum.

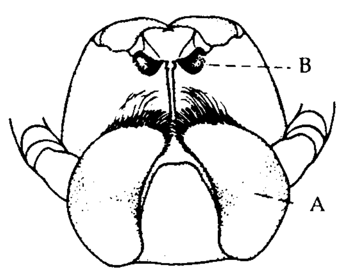



Figure 107. A: endites, B: keeled lamina.

70a Cheliceral retromargin not toothed but keeled (Fig. 107) ............................................................(Figs. 108, 109) *Gnaphosa* **spp.**
70b Cheliceral retromargin toothed or lacking teeth ....................................................................................................................71

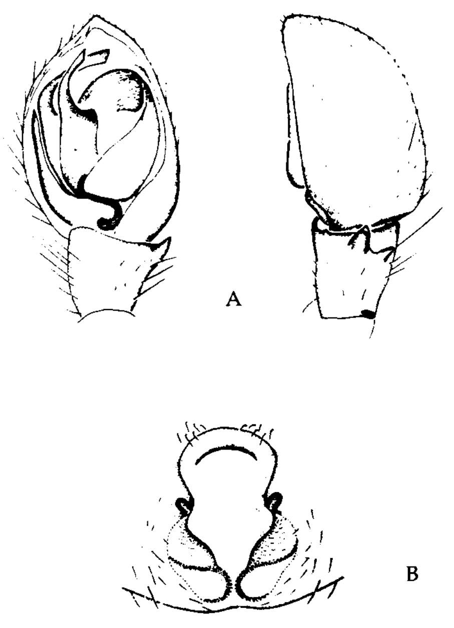


Figure 108. *Gnaphosa altudona* Chamberlin; A: palp (ventral, retrolateral views), B: epigynum.

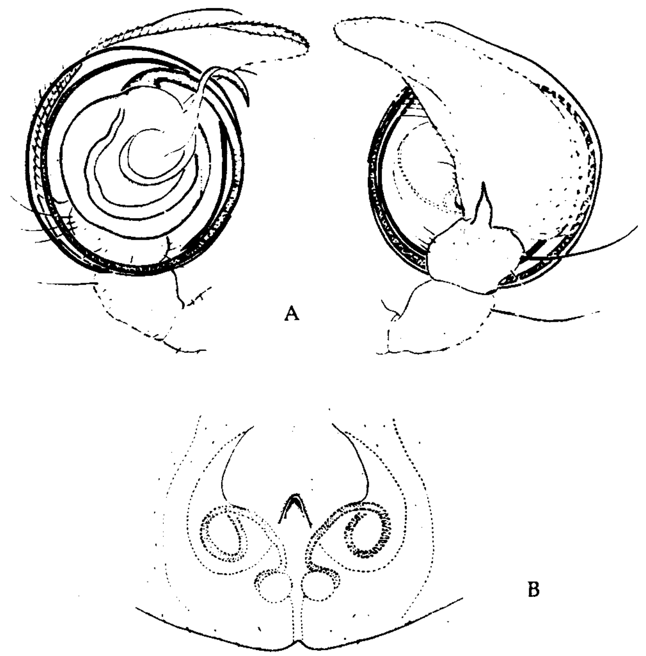


Figure 109. *Gnaphosa sericata* (L. Koch); A: palp (prolateral, retrolateral views), B: epigynum.

71a Cheliceral retromargin with 2 or 3 teeth ............................................................................*Talanites captiosus* **(Gertsch & Davis)**
71b Cheliceral retromargin with 0 to 1 tooth ..........................................................................................................................72

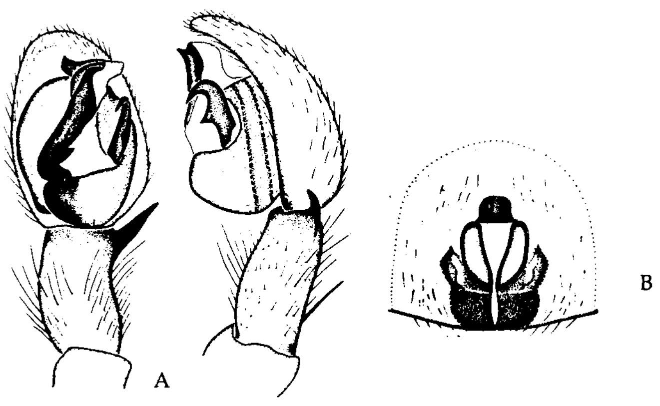


Figure 110. *Talanites captiosus* (Gertsch & Davis); A: palp (ventral, retrolateral views), B: epigynum.

72a Pale transverse markings present on abdomen (Fig. 111) .......... *Sergiolus ocellatus* **(Walckenaer)**
72a Pale transverse markings absent on abdomen .......... 73

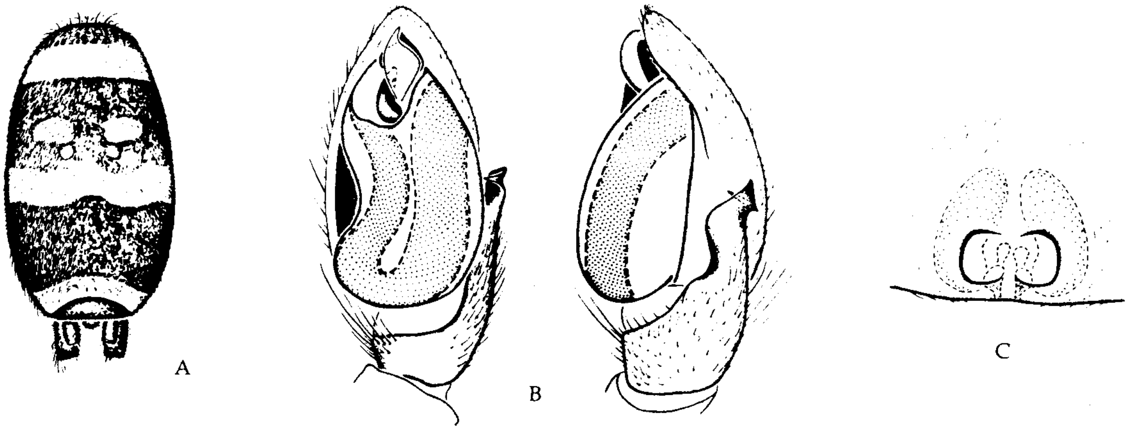



Figure 111. *Sergiolus ocellatus* (Walckenaer); A: dorsum of abdomen, B: palp (ventral, retrolateral views), C: epigynum.

73a Trochanters slightly notched .......... *Nodocion floridanus* **(Banks)**
73b Trochanters not notched .......... *Synaphosus paludis* **(Chamberlin & Gertsch)**

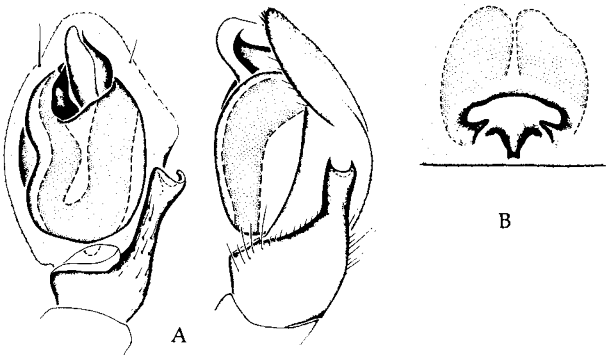



Figure 112. *Nodocion floridanus* (Banks); A: palp (ventral, retrolateral views), B: epigynum.

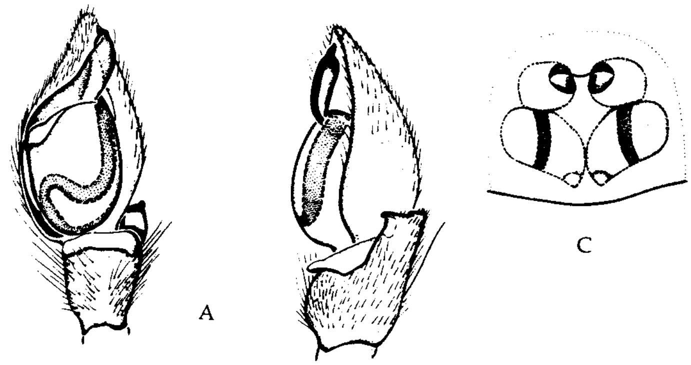



Figure 113. *Synaphosus paludis* (Chamberlin & Gertsch); A: palp (ventral, retrolateral views), B: epigynum.

74a Spinnerets (6), in a transverse row (Fig. 114)...**Hahniidae** (1 species) .......... *Neoantistea mulaiki* **Gertsch**
74b Spinnerets in the normal arrangement .......... 75

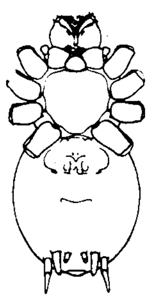


Figure 114. Spiracle of *Neoantistea* sp.

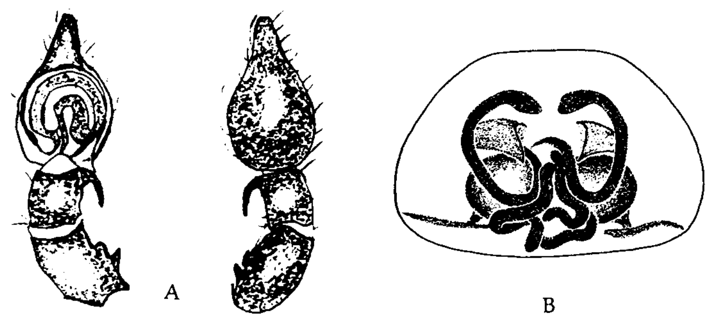



Figure 115. *Neoantistea mulaiki* Gertsch; A: palp (ventral, dorsal views), B: epigynum.

75a A distinct prolateral row of long spines present on tibia and metatarsus I and II, the shorter spines increasing in length distally (Fig. 116)... **Mimetidae** (4 species) ........ 76
75b Lacking distinct spines on tibia and metatarsus I and II ........ 79

76a Leg I 11/2 times as long as leg IV; chelicera with a conspicuous heavy bristle on inner margin near fang ........ 77
76b Leg I otherwise, bristle absent. ........ ***Ero* sp.**

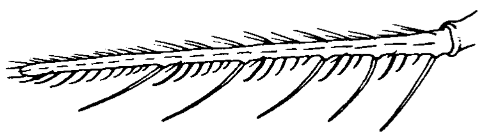


Figure 116. Spination in metatarsus I of *Mimetus*.

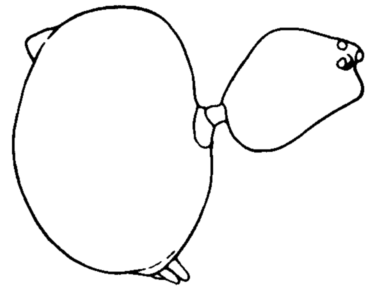


Figure 117. Lateral view of *Ero* sp.

77a Carapace with 4 thin black lines extending from eyes (Fig. 118) ........ *Mimetus hesperus* **Chamberlin**
77b Carapace marked otherwise ........ 78

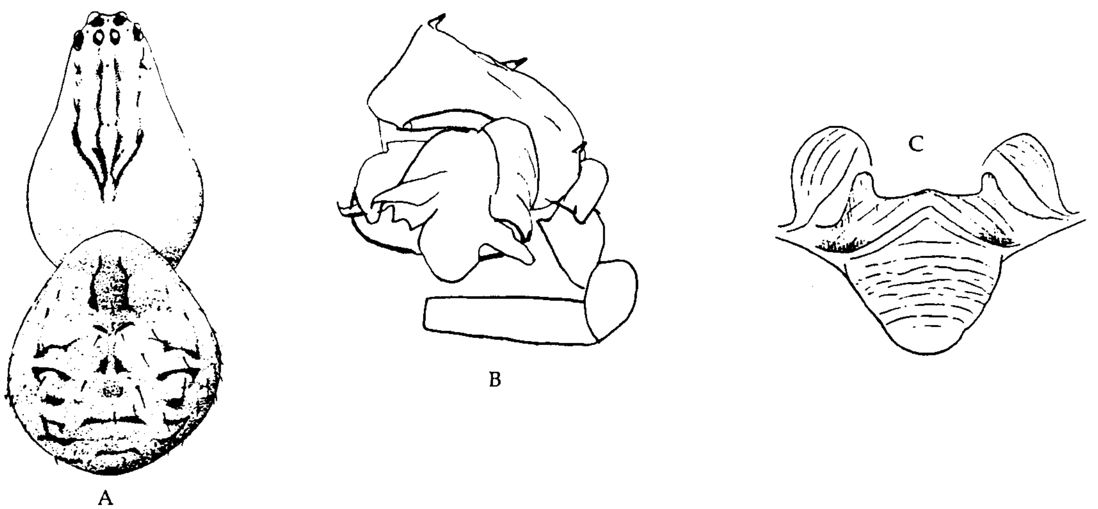



Figure 118. *Mimetus hesperus* Chamberlin; A: dorsum, B: palp (subectal view), C: epigynum.

78a Dark blotches along middle of carapace (Fig. 119) ........................................................... *Mimetus puritanus* **Chamberlin**
78b Group of variously branching black lines on carapace, anterior portion W-shaped (Fig. 120) ........................................ ........................................................................................................................ *Mimetus notius* **Chamberlin**

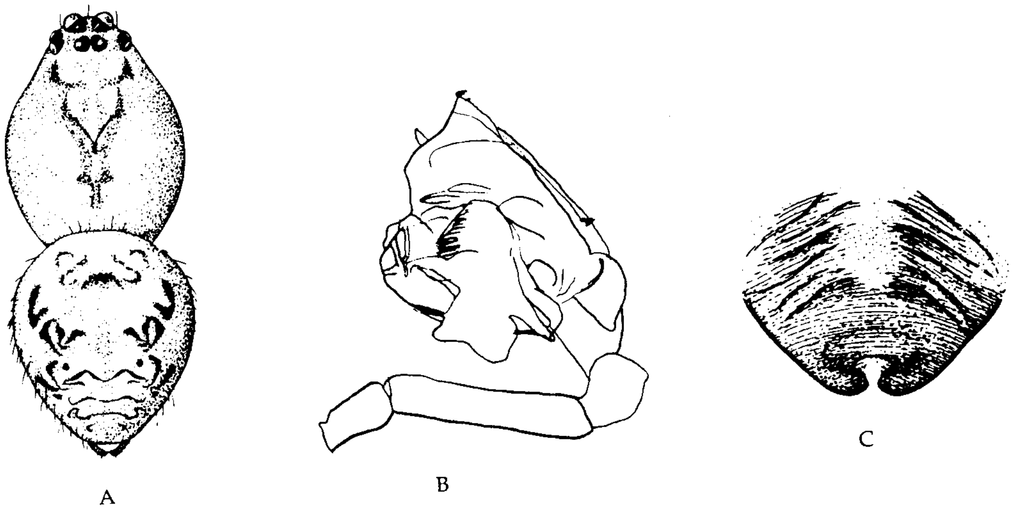



Figure 119. *Mimetus puritanus* Chamberlin; A: dorsum of female, B: palp (subectal view), C: epigynum.

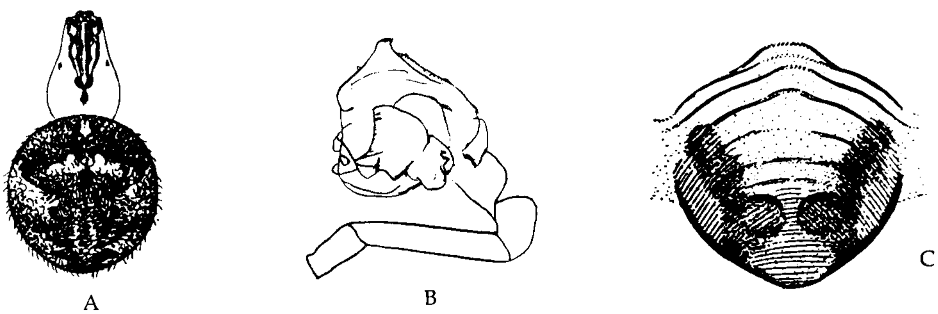



Figure 120. *Mimetus notius* Chamberlin; A: dorsum of female, B: palp (subectal view), C: epigynum.

79a Eyes forming a hexagon; clypeus broadly tall (Fig. 121)...**Oxyopidae** (3 species) ........................................ 80
79b Eyes not forming a hexagon; clypeus reduced ........................................................................................ 82

80a Posterior cheliceral margin without teeth; ALE row distinctly wider than PME row, posterior eye row only slightly procurved; body large, bright green (Fig. 121) ................................................ *Peucetia viridans* **(Hentz)**
80b Posterior cheliceral margin with a single tooth on each side; posterior eye row strongly procurved; body smaller; green coloration lacking ........................................................................................................ 81

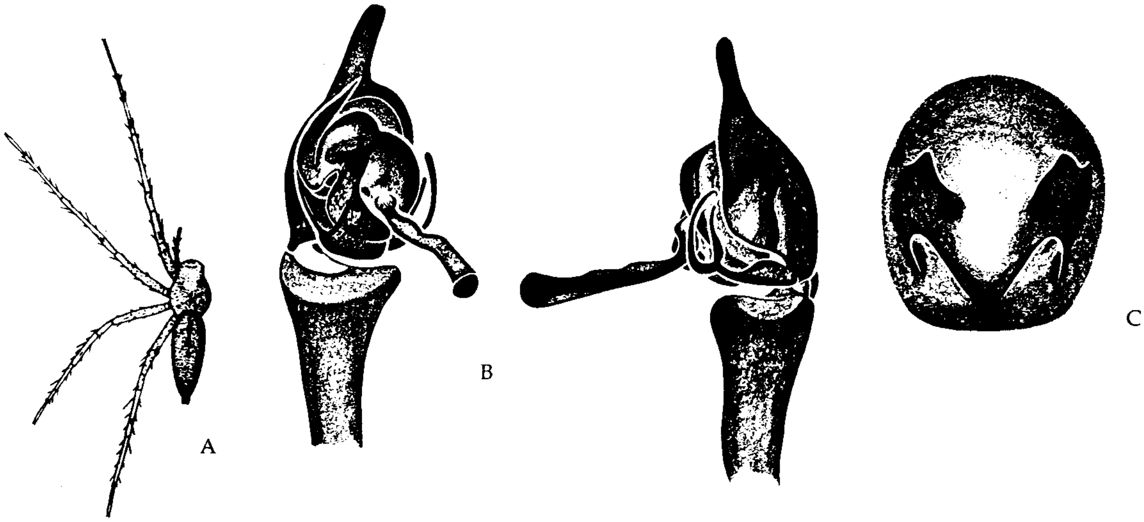



Figure 121. *Peucetia viridans* (Hentz); A: dorsum of female, B: palp (ventral, retrolateral views), C: epigynum.

81a Distinct black lines on the ventral surfaces of femora I and II present .................................................... *Oxyopes salticus* **Hentz**
81b Distinct black lines on the ventral surfaces of femora I and II absent ......................................................... *Oxyopes apollo* **Brady**


Figure 122. *Oxyopes salticus* Hentz; A: face, dorsum of female, B: palp (ventral, retrolateral views), C: epigynum.

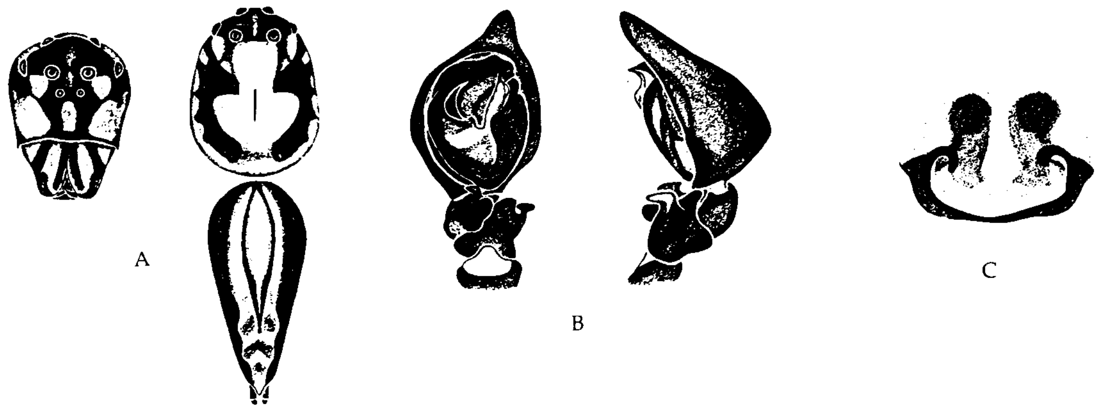


Figure 123. *Oxyopes apollo* Brady; A: face, dorsum of male, B: palp (ventral, retrolateral views), C: epigynum.

82a Tarsi with trichobothria (Fig. 124) .......... 83
82b Tarsi lacking trichobothria .......... 95

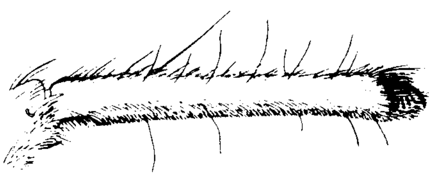


Figure 124. Tarsal trichobothria arrangements of *Hogna*.

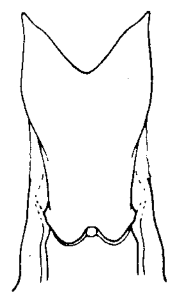


Figure 125. *Dolomedes* lorum.

83a Posterior row of eyes not strongly recurved; anterior piece of lorum (Fig. 125) with a notch on anterior part (Fig. 125) or a transverse suture between the two pieces (Fig. 125)... **Pisauridae** (1 species) (Fig. 126) .......... *Dolomedes triton* **(Walckenaer)**
83b Posterior row of eyes strongly recurved; anterior piece of lorum of pedicel fitting into a notch of posterior part (Fig. 127)...**Lycosidae** (13 species) .......... 84

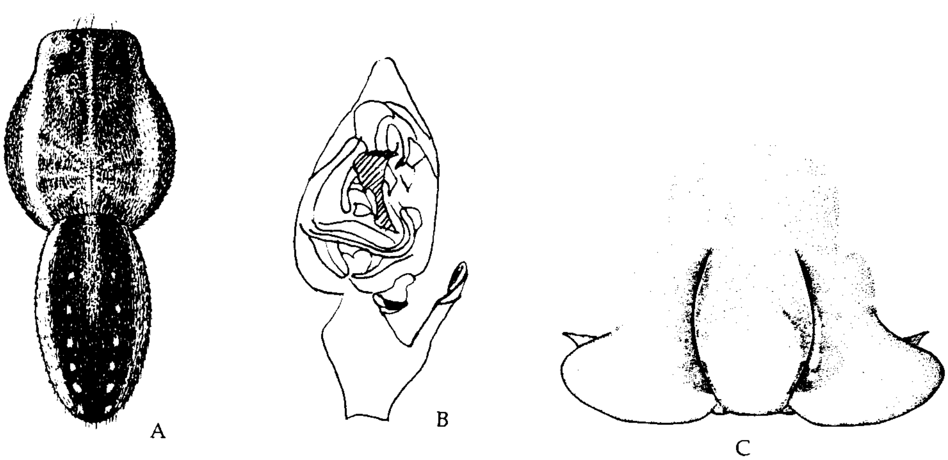


Figure 126. *Dolomedes triton* (Walckenaer); A: dorsum, B: palp, C: epigynum.

84a Carapace typically higher in the head region, dark V-shaped mark lacking .......... 85
84b Carapace as high in the thoracic region as in the cephalic, cephalic region with a dark V-shaped mark within a central pale area (Fig. 128) .......... 87

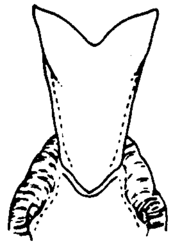


Figure 127. *Hogna* lorum.

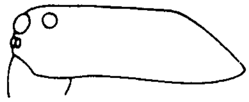


Figure 128. Carapace of *Pirata* sp.

85a Tibia IV with the proximal dorsal spine typically thinner or more drawn out than the distal one .......... *Allocosa absoluta* **(Gertsch)**
85b Tibia IV with the two dorsal spines about equally stout .......... 86

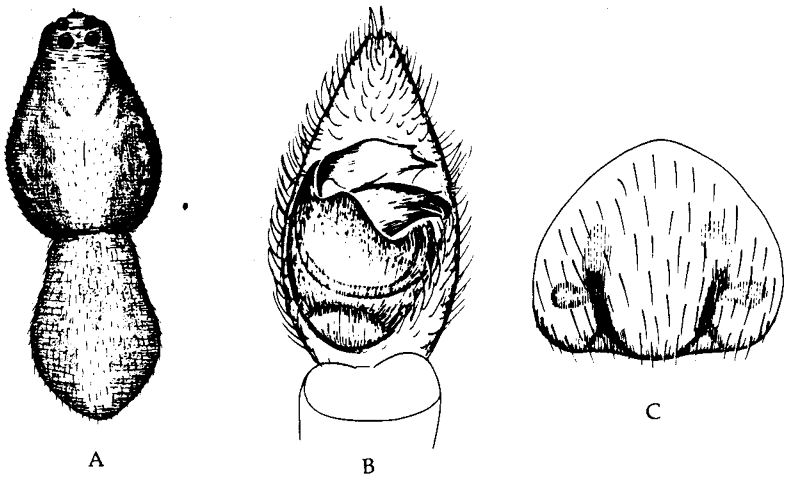
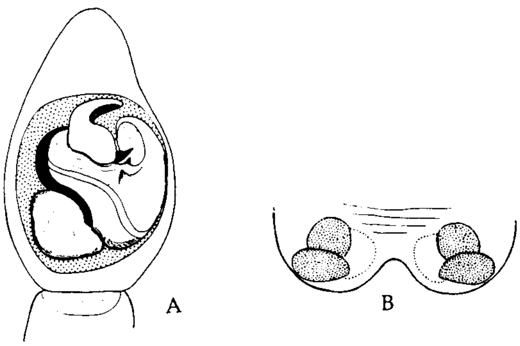



Figure 129. *Allocosa absoluta* (Gertsch); A: dorsum, B: palp, C: epigynum.

86a Labium not longer than wide, typically wider than long, with basal articular notches about 1/4 its length .......... 88
86b Labium longer than wide with the basal articular notches typically about 1/3 its length .......... 91

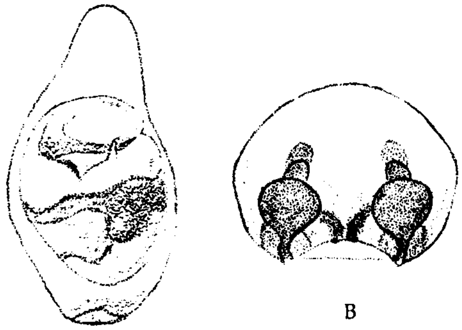
87a Anterior eye row as wide as posterior median row, straight .......... *Pirata seminola* **Gertsch & Wallace**
87b Anterior eye row narrower than posterior median row .......... *Pirata davisi* **Wallace & Exline**



A

B

Figure 130. *Pirata seminola* Gertsch & Wallace; A: palp, B: epigynum.



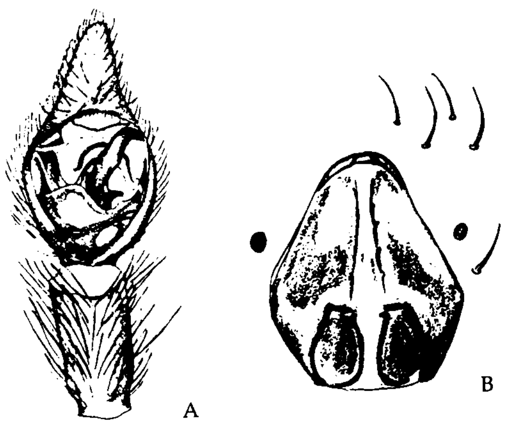
A

B

Figure 131. *Pirata davisi* Wallace & Exline; A: palp, B: epigynum.

88a Male palpus covered dorsally with reflective white setae ........ 89
88b Palpus not as described above ........ 90

89a Distal half or more of cymbium of male palp covered with white setae ........ *Pardosa sternalis* **(Thorell)**
89b Patella and tibia of male palp with white setae (Fig. 133) ........ *Pardosa atlantica* **Emerton**



A

B

Figure 132. *Pardosa sternalis* (Thorell); A: palp, B: epigynum.

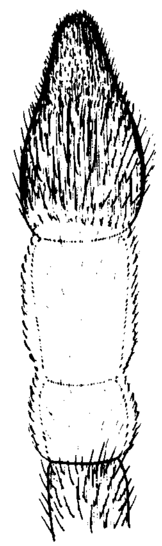


Figure 133. *Pardosa atlantica* Emerton; dorsum of male palp.

90a Abdomen dull black .................................................. *Pardosa pauxilla* **Montgomery**
90b Abdomen yellow brown .................................................. *Pardosa delicatula* **Gertsch & Wallace**, *Pardosa milvina* **(Hentz)**

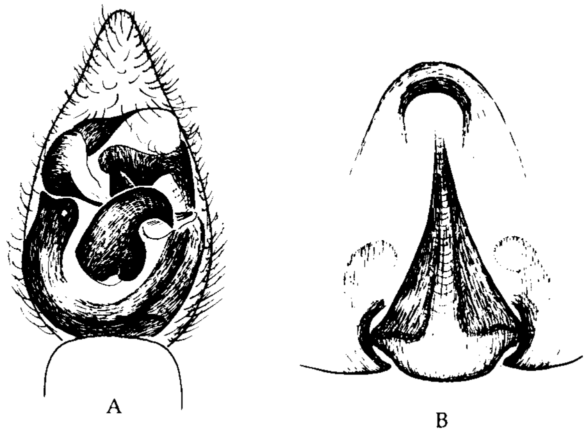



Figure 134. *Pardosa pauxilla* Montgomery; A: palp, B: epigynum.

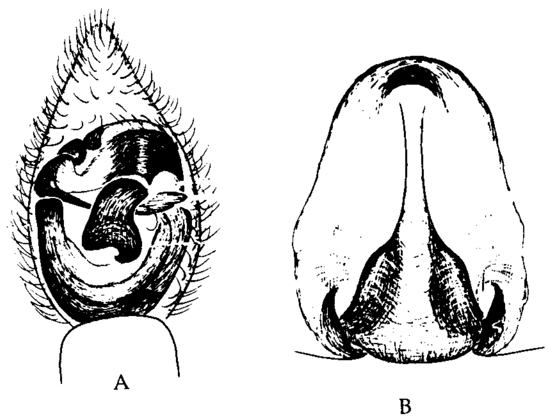



Figure 135. *Pardosa delicatula* Gertsch & Wallace; A: palp, B: epigynum.

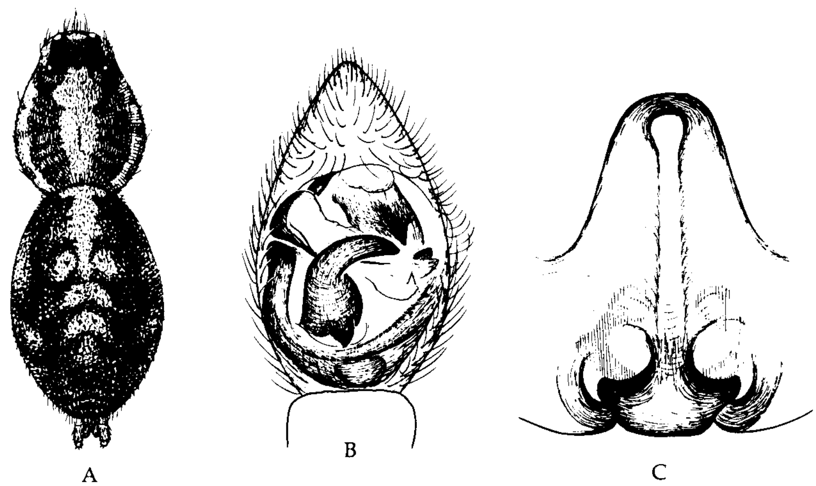
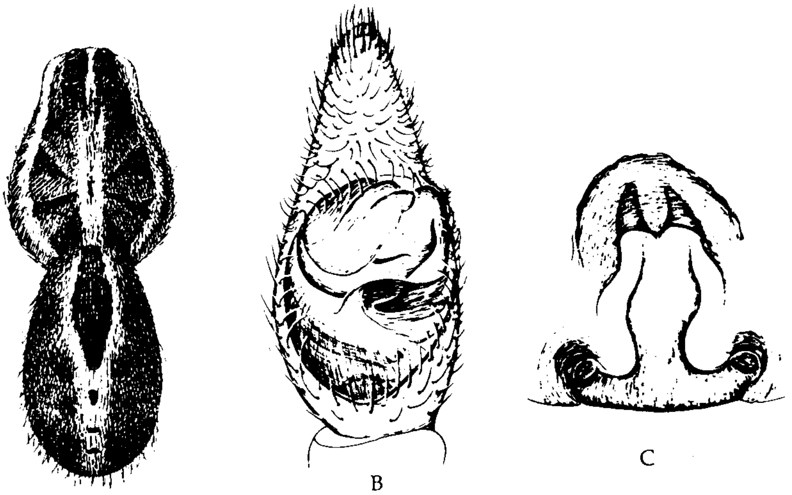



Figure 136. *Pardosa milvina* (Hentz); A: dorsum, B: palp, C: epigynum.

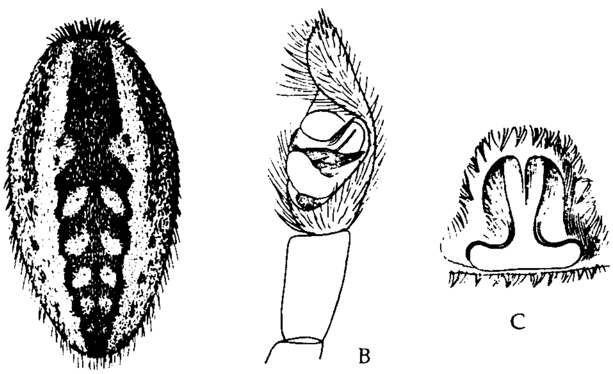
91a Lanceolate marking on abdomen (Fig. 137). .................................................. *Schizocosa avida* **(Walckenaer)**
91b Lacking lanceolate abdominal mark .................................................. 92



A B C

Figure 137. *Schizocosa avida* (Walckenaer); A: dorsum, B: palp, C: epigynum.

92a Median dark band on abdomen notched on edges (Fig. 138) ........ *Rabidosa rabida* **(Walckenaer)**
92b Band not notched ........ 93



A B C

Figure 138. *Rabidosa rabida* (Walckenaer); A: abdomen, B: palp, C: epigynum.

93a Genitalia as in Figure 139 ........ *Varacosa acompa* **(Chamberlin)**
93b Genitalia otherwise ........ 94

94a Abdomen pale (Fig. 140) ........ *Hogna antelucana* **(Montgomery)**
94b Abdomen dark (Fig. 141) ........ *Hogna helluo* group nr. *georgicola* **(Walckenaer)**

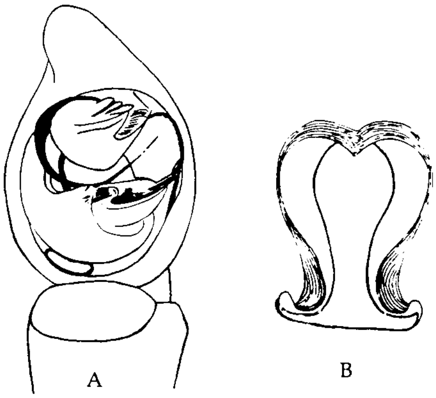



Figure 139. *Varacosa acompa* (Chamberlin); A: palp, B: epigynum.

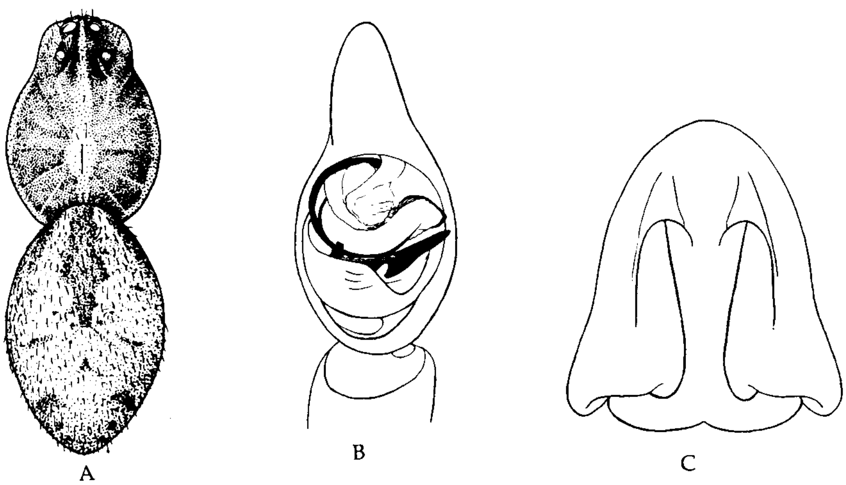



Figure 140. *Hogna antelucana* (Montgomery); A: dorsum, B: palp, C: epigynum.

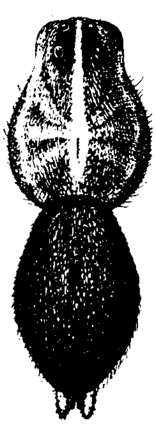


Figure 141. Dorsum of *Hogna helluo* (Walckenaer).

95a Chelicera with a boss; clypeus lower than the median ocular region (Fig. 142); web typically an orb; eyes homogeneous ........ 96
95b Chelicera lacking a boss; clypeus typically as high as or higher than median ocular area; web irregular; eyes heterogeneous...**Linyphiidae** (11 species) ........ 117

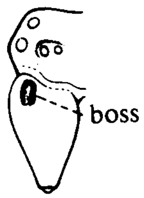



Figure 142. Boss on chelicerae of *Eustala.*

96a Microscopic denticles between cheliceral teeth; body length <1mm...**Mysmenidae** (1 species) ........ *Calodipoena incredula* **Gertsch & Davis**
96b Denticles absent; body length > 1mm ........ 97

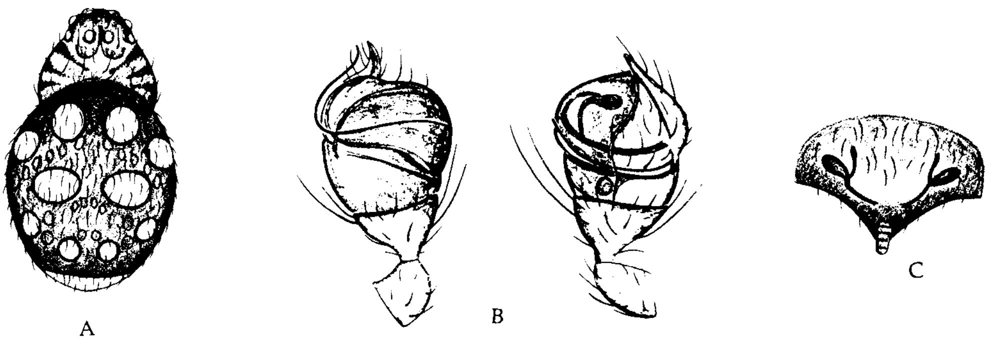



Figure 143. *Calodipoena incredula* Gertsch & Davis; A: dorsum of female, B: palp (retrolateral, prolateral views), C: epigynum.

97a Femora without trichobothria; chelicerae not enlarged...**Araneidae** (20 species) ........ 98
97b Femora with trichobothria; chelicerae enlarged, projecting...**Tetragnathidae** (2 species) ........ 116

98a Abdomen hardened, dorsally flattened with large spiny projections; spinnerets platformed and delimited by a circular space ........ 99
98b Abdomen and spinnerets not as above ........ 100

99a Female with 5 pairs of conical pointed tubercles; males with a highly elongate abdomen (Fig. 144) ........ *Micrathena gracilis* **(Walckenaer)**
99b Female with 3 pairs of conical pointed tubercles; abdomen distinctly arrow shaped, males with shorter abdomen (Fig. 145) ........ *Micrathena sagittata* **(Walckenaer)**

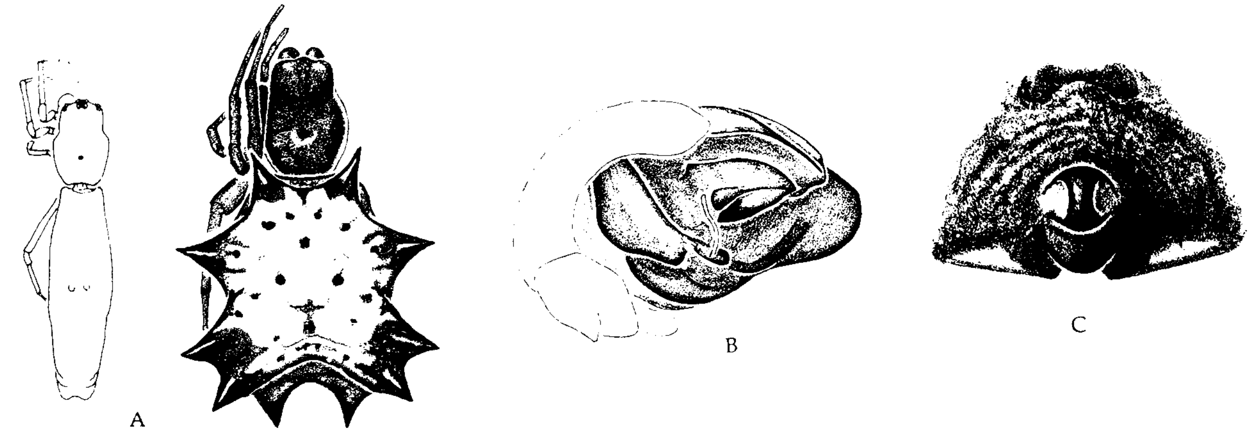



Figure 144. *Micrathena gracilis* (Walckenaer); A: dorsum of male, female, B: palp (mesal view), C: epigynum.

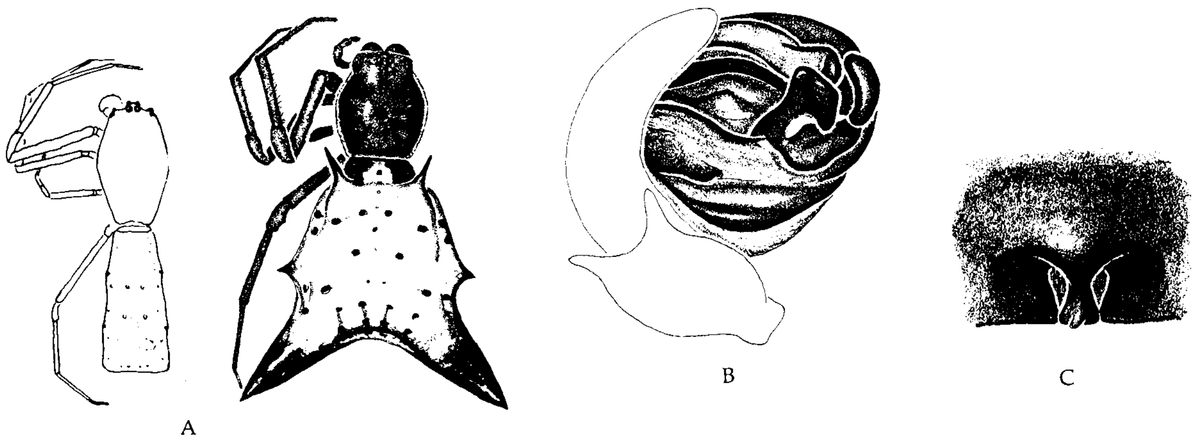



Figure 145. *Micrathena sagittata* (Walckenaer); A: dorsum of male, female, B: palp (mesal view), C: epigynum.

100a Posterior eye row strongly procurved, ALE smaller than PLE ........ 101
100b Posterior eye row straight or recurved ........ 103

101a Anterior row of eyes equally separated or AME closer to the ALE than to each other; females small, < 6 mm (Fig. 146) ........ *Gea heptagon* **(Hentz)**
101b AME closer to each other than ALE; females > 9 mm ........ 102

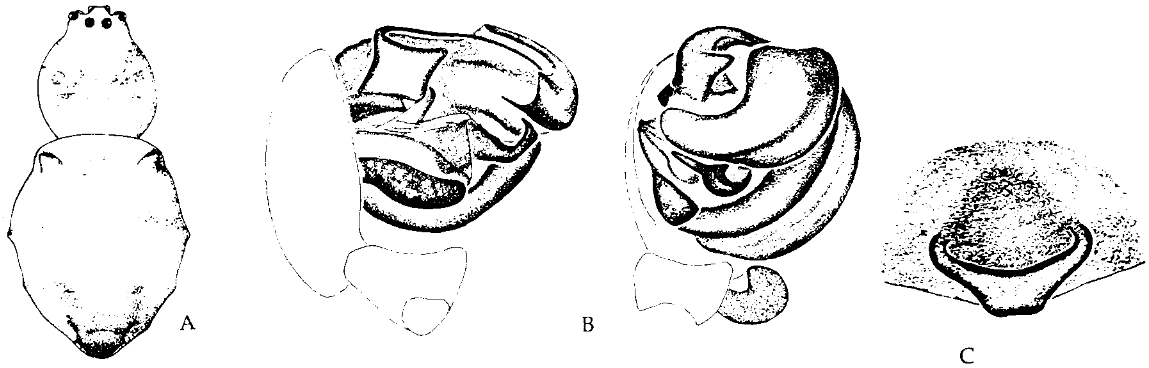



Figure 146. *Gea heptagon* (Hentz); A: dorsum, B: palp (mesal, ventral views), C: epigynum.

102a Anterior of abdomen notched to form a hump on either side of the pedicel, black and yellow (Fig. 147) .................................................. *Argiope aurantia* **Lucas**

102b Anterior of abdomen lacking a notch dorsally, humps absent, silvery (Fig. 148) .......................... *Argiope trifasciata* **(Forskal)**

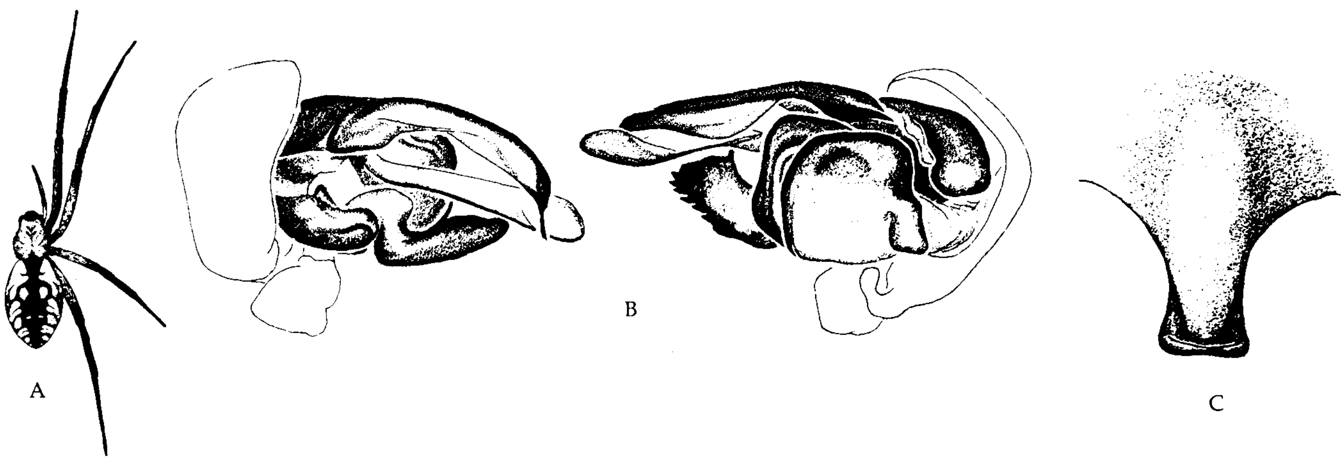



Figure 147. *Argiope aurantia* Lucas; A: dorsum, B: palp (mesal, ectal views), C: epigynum.

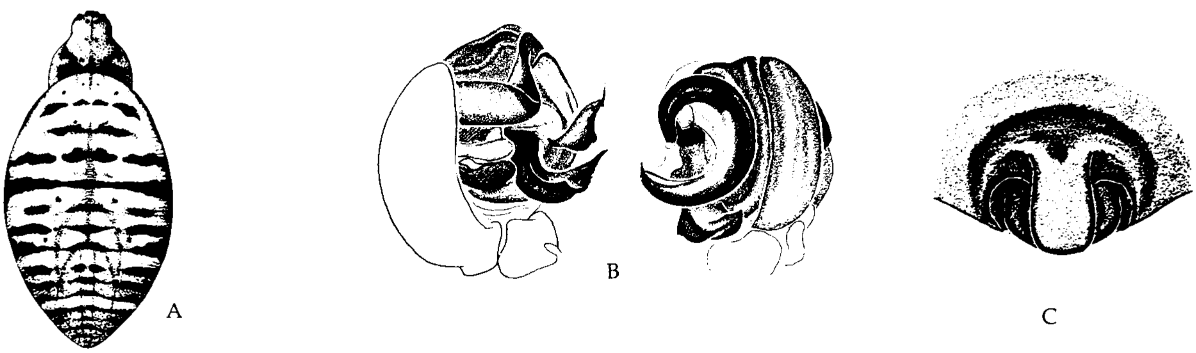



Figure 148. *Argiope trifasciata* (Forskal); A: dorsum, B: palp (mesal, ventral views), C: epigynum.

103a A double row of long, thin, feathery hairs present on prolateral surface of tibia III (Fig. 149); thoracic part of cephalothorax higher than cephalic section .......... 104
103b Feathery hairs absent from tibia III; cephalothorax not as above .......... 105

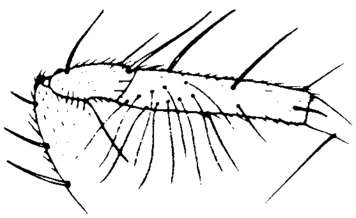


Figure 149. Feathery hairs on tibia III of *Mangora.*

104a Abdomen with 1 black spot anteriorly (Fig. 150).......... *Mangora fascialata* **Franganillo**
104b Abdomen with 4 black spots anteriorly (Fig. 151) .......... *Mangora gibberosa* **(Hentz)**

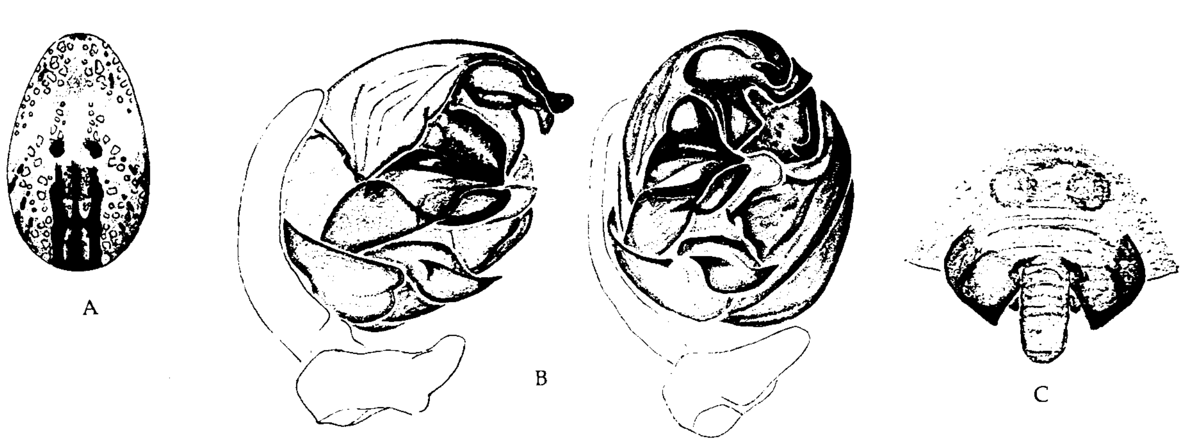



Figure 150. *Mangora fascialata* Franganillo; A: abdomen of female, B: palp (mesal, ventral views), C: epigynum.

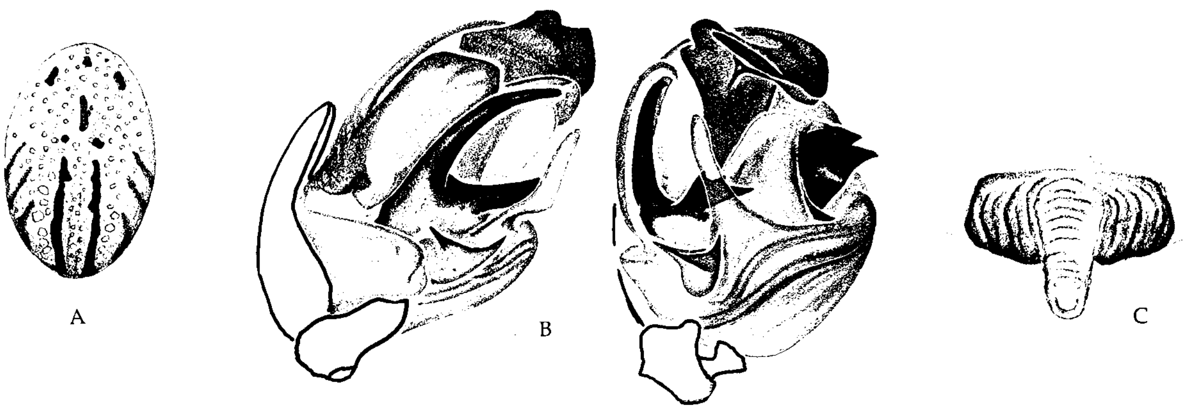



Figure 151. *Mangora gibberosa* (Hentz); A: abdomen of female, B: palp (mesal, ventral views), C: epigynum.

105a Abdomen hardened with pointed conical tubercles posteriorly, laterally, and anteriorly (Fig. 152) ........ *Acanthepeira stellata* **(Walckenaer)**
or rarely ........ *Acanthepeira cherokee* **Levi**
105b Abdomen with fewer tubercles or none ........ 106

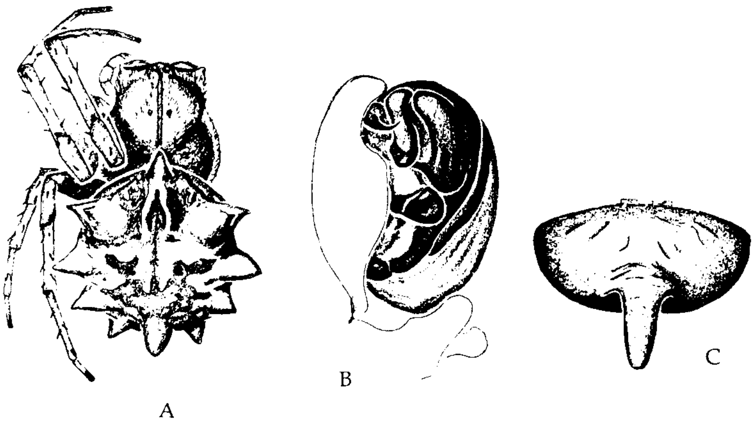



Figure 152. *Acanthepeira stellata* (Walckenaer); A: dorsum of female, B: palp, C: epigynum.

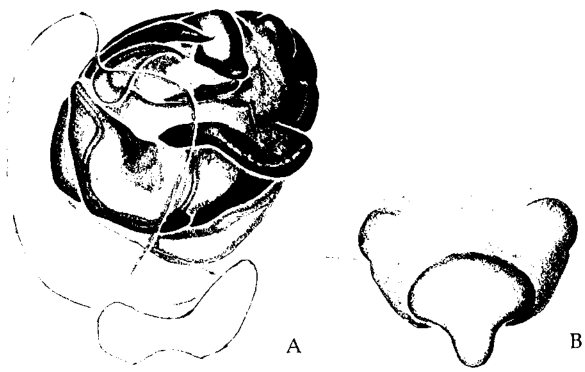



Figure 153. *Acanthepeira cherokee* Levi; A: palp (mesal view), B: epigynum.

106a Abdomen triangular ovate, flattened dorsally ........ 107
106b Abdomen not triangular ovate or flattened dorsally ........ 109

107a Scape of epigynum long, thin, extending almost to spinnerets; male palps very large (Fig. 154) ........ *Eriophora ravilla* **(C.L. Koch)**
107b Scape of female short; male palps smaller ........ 108

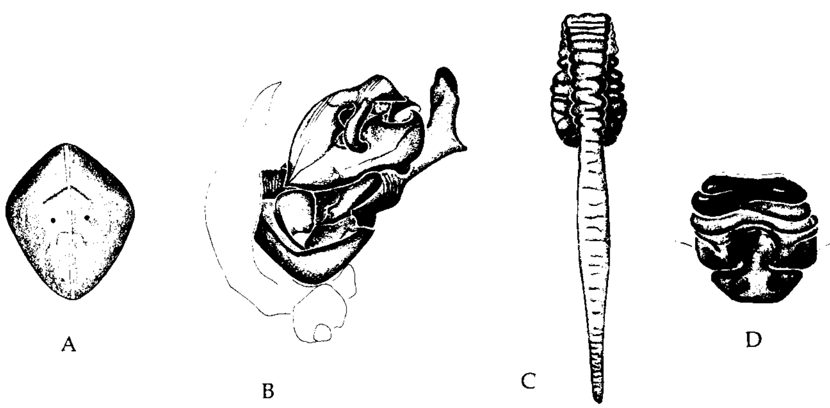



Figure 154. *Eriophora ravilla* (C. L. Koch); A: abdomen of female, B: palp (mesal view), C: epigynum, D: epigynum base with scape broken off.

108a Abdomen with 1 posterior tubercle, abdomen grey with central triangle and black, scalloped markings (Fig. 155) ............ ........................................ *Eustala anastera* **(Walckenaer)**
108b Abdomen without posterior tubercle (Fig. 156) ........................................ *Eustala cepina* **(Walckenaer)**

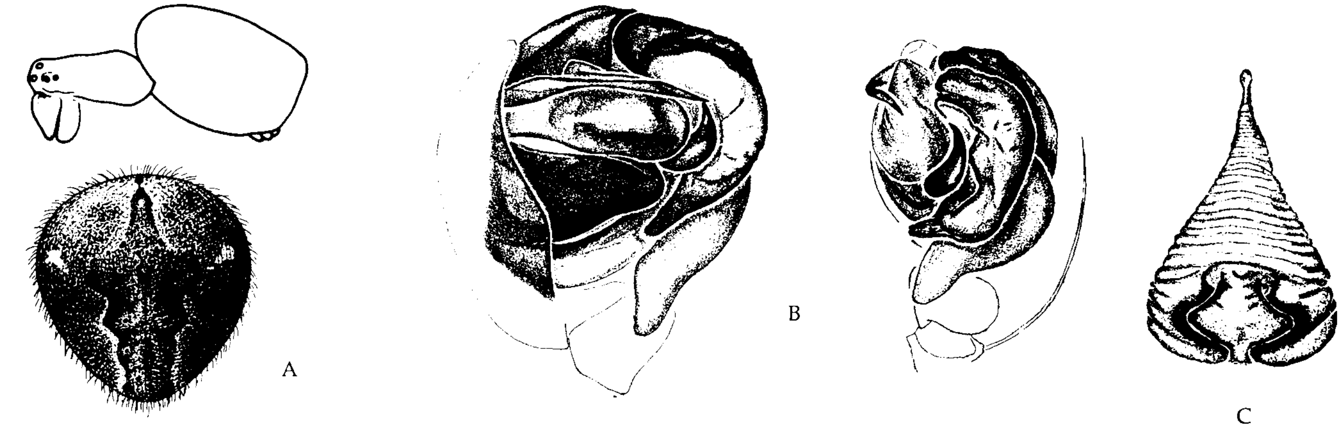



Figure 155. *Eustala anastera* (Walckenaer); A: lateral view, abdomen, B: palp (mesal, ventral views), C: epigynum.

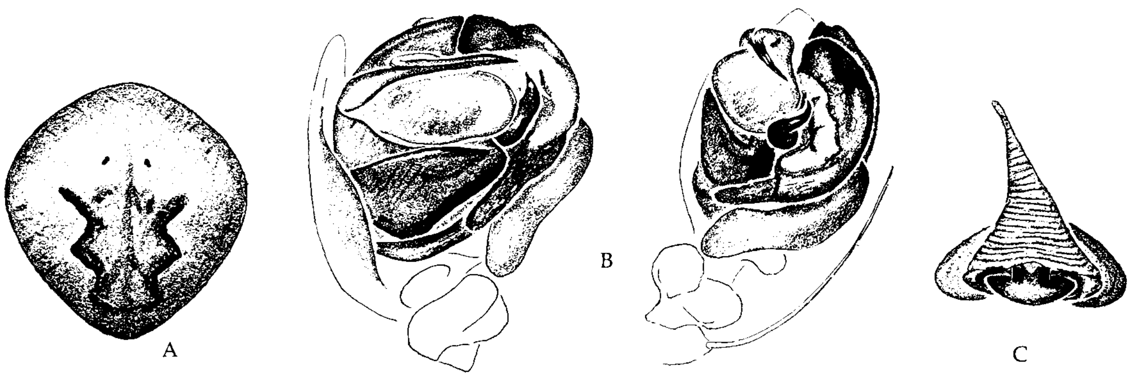



Figure 156. *Eustala cepina* (Walckenaer); A: abdomen of female, B: palp (mesal, ventral views), C: epigynum.

109a Abdomen elongate oval with distinctive triangular folium (Fig. 157) ........................................ *Acacesia hamata* **(Hentz)**
109b Abdomen without abdominal pattern ........................................ 110

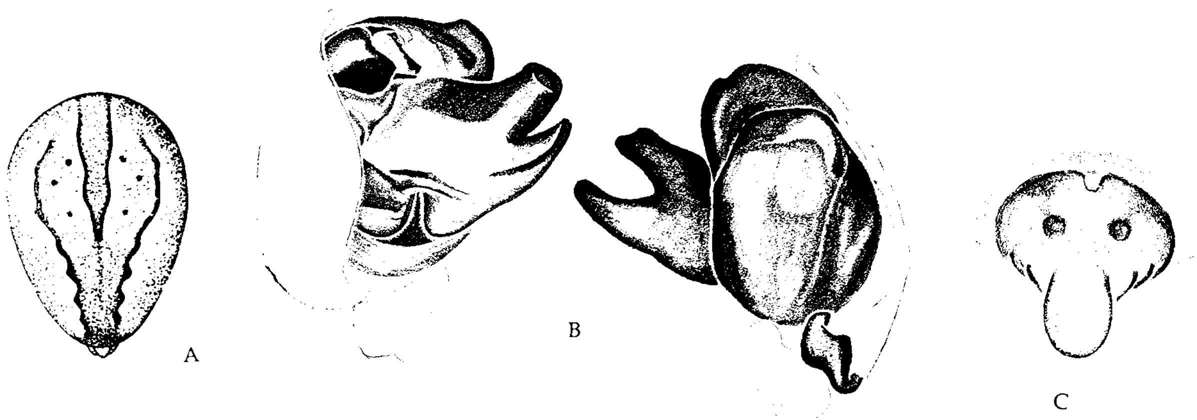



Figure 157. *Acacesia hamata* (Hentz); A: abdomen, B: palp (mesal, ventral views), C: epigynum.

110a Abdomen elongate with a lateral hump on each side of anterior portion, abdominal pattern distinct (Fig. 158) .................... ........................................................................................................................................ *Mecynogea lemniscata* **(Walckenaer)**
110b Abdomen more rounded than elongate, patterns not as above ........................................................................................ 111

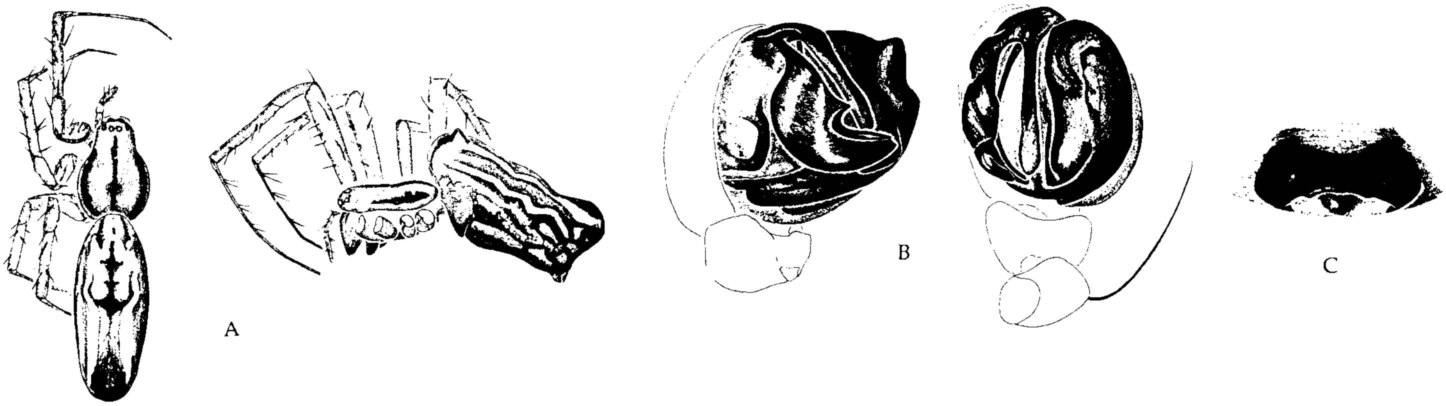



Figure 158. *Mecynogea lemniscata* (Walckenaer); A: female (dorsal, lateral views), B: palp (mesal, ventral views), C: epigynum.

111a With a caudal tubercle in females; eyes elevated on tubercles (Fig. 159) .................................. *Cyclosa turbinata* **(Walckenaer)**
111b Abdomen lacking caudal tubercle ........................................................................................................................ 112

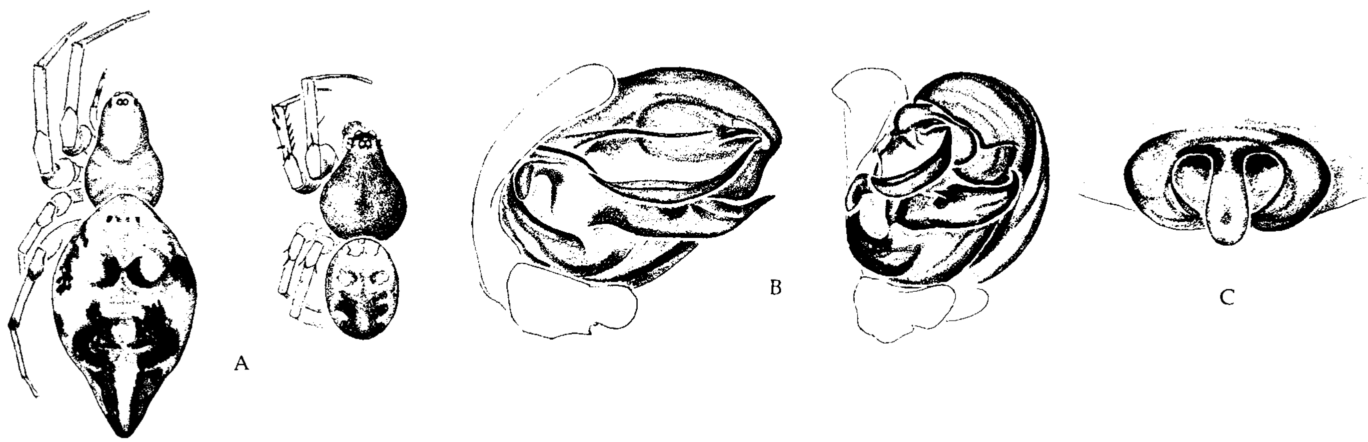



Figure 159. *Cyclosa turbinata* (Walckenaer); A: dorsum of female, male, B: palp (mesal, ventral views), C: epigynum.

112a Thoracic groove on dorsal carapace longitudinal (Fig. 160) ........................................................................................ 113
112b Thoracic groove transverse, straight, or recurved (Fig. 161) ........................................................................................ 115

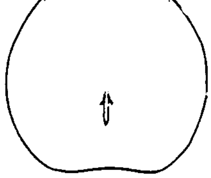


Figure 160. Longitudinal groove, *Neoscona*.

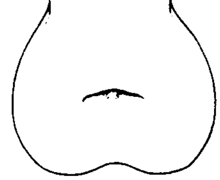


Figure 161. Traverse, recurved groove, *Araneus*.

113a PME smaller than AME; carapace orange brown anteriorly ranging to yellow posteriorly; abdomen not higher anteriorly (Fig. 162) .......... *Metazygia wittfeldae* **(McCook)**
113b Abdomen higher on dorsal anterior end; eyes and color not matching above description .......... 114

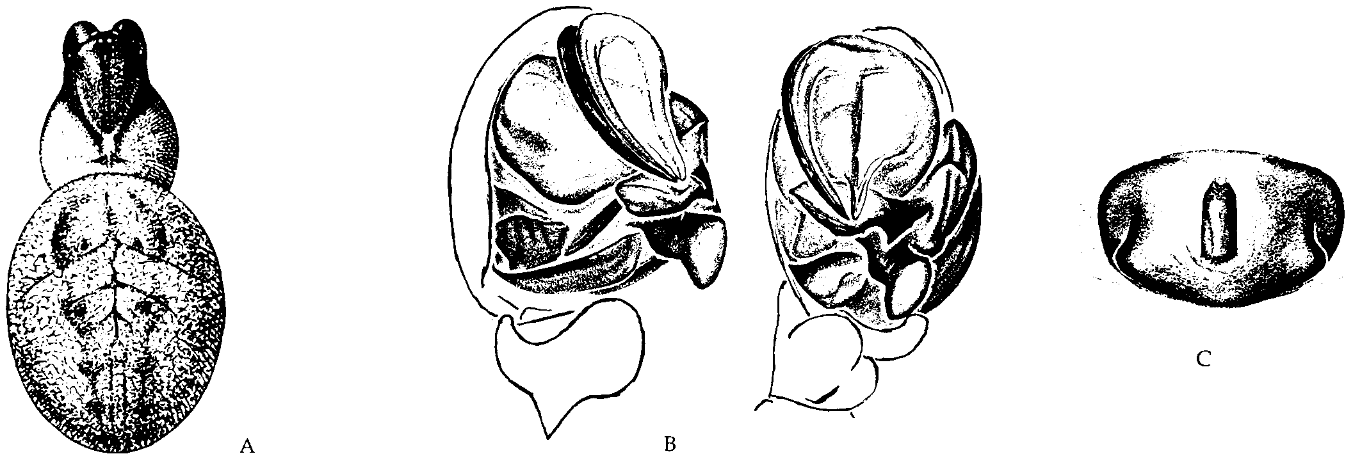



Figure 162. *Metazygia wittfeldae* (McCook); A: dorsum, B: palp (mesal, ventral views), C: epigynum.

114a Abdomen of female subtriangular, markings well defined (Fig. 163) .......... *Neoscona utahana* **(Chamberlin)**
114b Abdomen of female more rounded, pattern more obscure (Fig. 164) .......... *Neoscona arabesca* **(Walckenaer)**

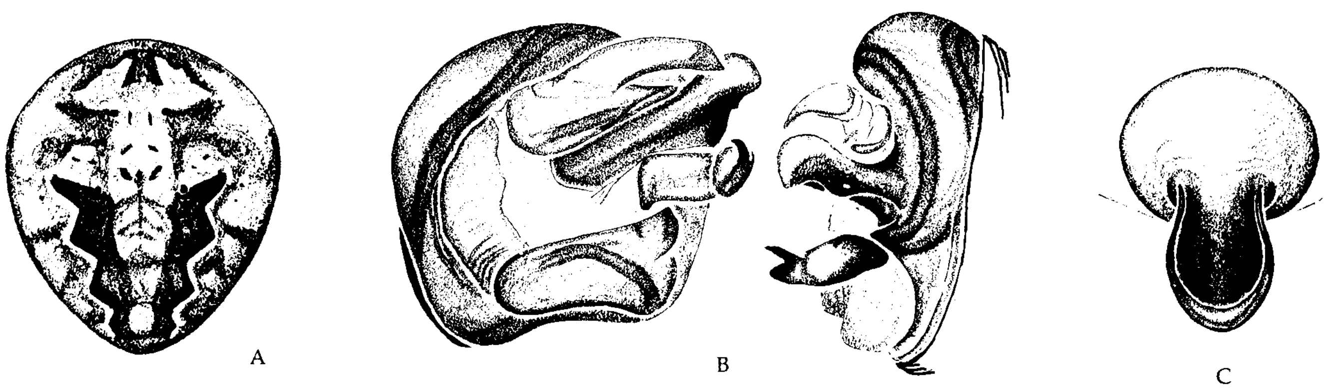



Figure 163. *Neoscona utahana* (Chamberlin); A: abdomen of female, B: palp (ventral, lateral views), C: epigynum.

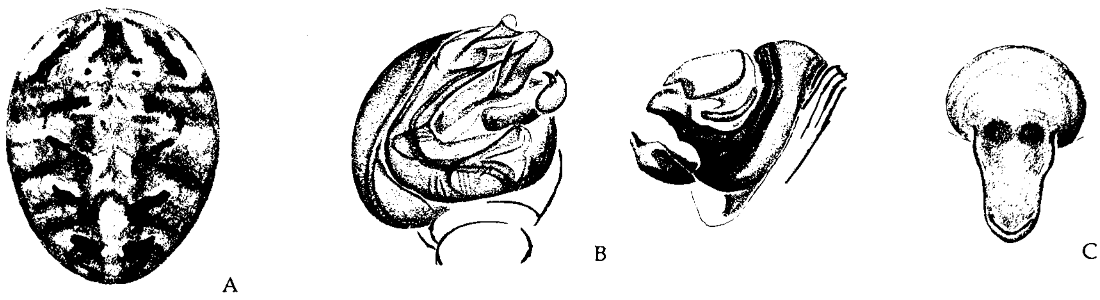



Figure 164. *Neoscona arabesca* (Walckenaer); A: abdomen of female, B: palp (ventral, lateral views), C: epigynum.

115a Shiny, legs short, patella I plus tibia I about the same length as carapace .......................................... *Hypsosinga rubens* **(Hentz)**
115b Not shiny; abdomen higher toward anterior end; patella I plus tibia I together 1 1/2 or more times longer than carapace ... ........................................................................................................................................ *Araniella displicata* **(Hentz)**

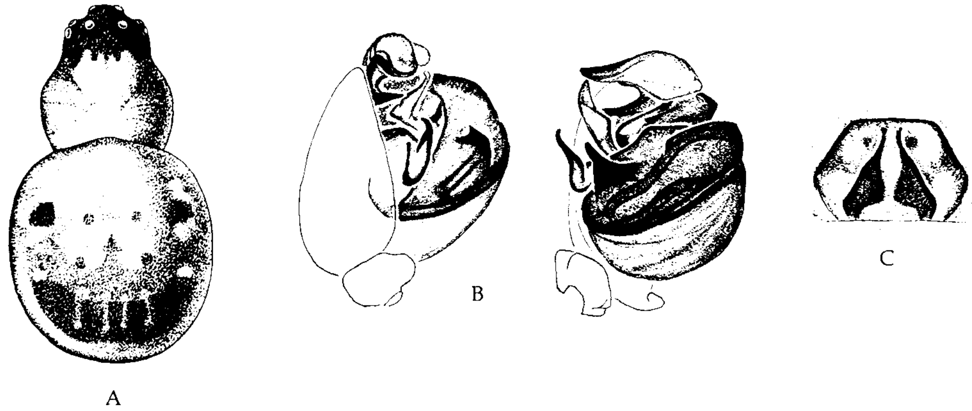



Figure 165. *Hypsosinga rubens* (Hentz); A: dorsum, B: palp (mesal, ventral views), C: epigynum.

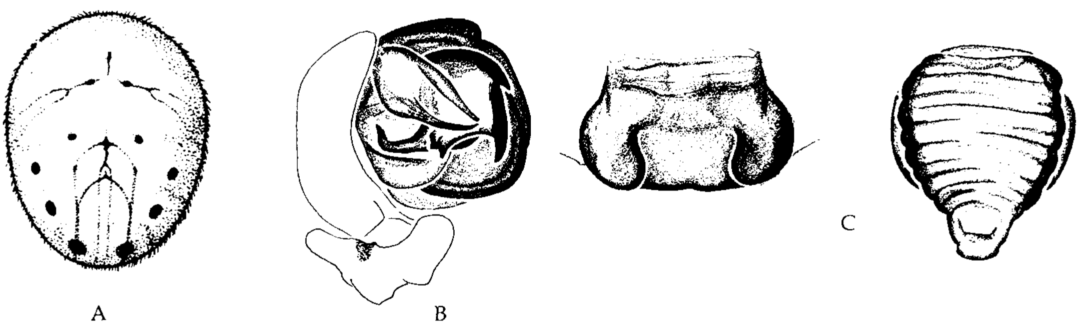



Figure 166. *Araniella displicata* (Hentz); A: abdomen, B: palp (mesal view), C: epigynum without scape, with scape.

116a Abdomen spherical (Fig. 167) ........................................................................................................ *Glenognatha foxi* **(McCook)**
116b Abdomen elongate (Fig. 168) ........................................................................................................ *Tetragnatha laboriosa* **Hentz**

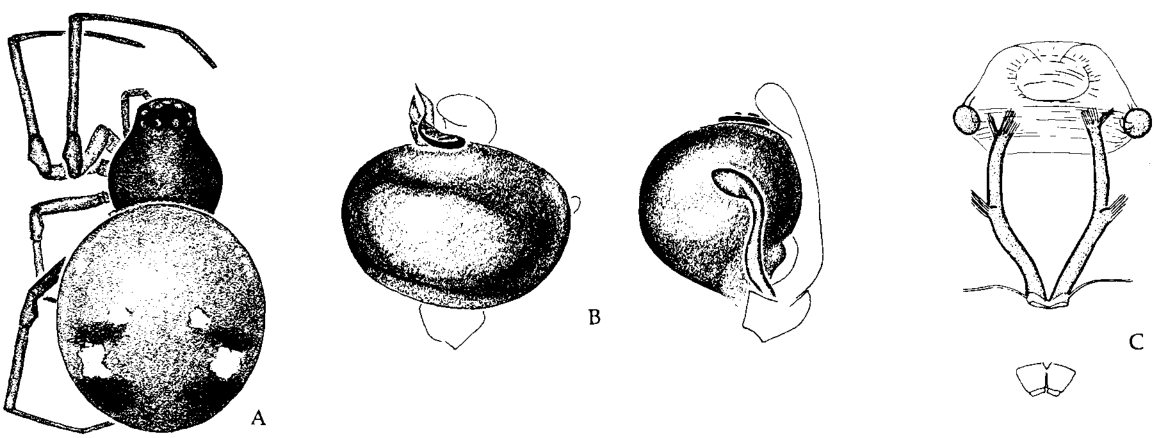



Figure 167. *Glenognatha foxi* (McCook); A: dorsum of female, B: palp (ventral, lateral views), C: epigynum.

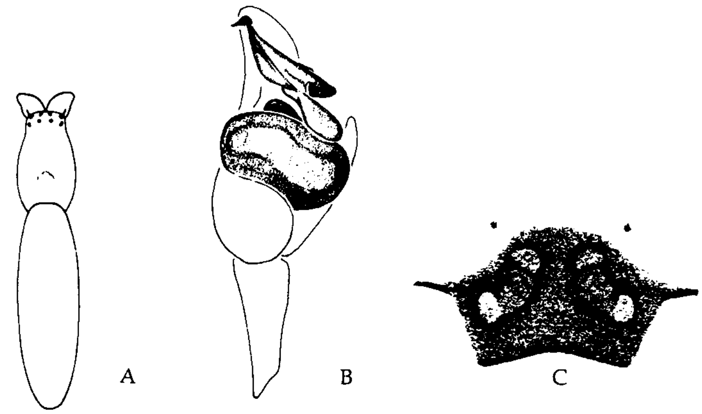



Figure 168. *Tetragnatha laboriosa* Hentz; A: dorsum, B: palp, C: epigynum.

117a One dorsal macroseta on tibia IV; all metatarsi without macrosetae .......... 118
117b Two dorsal macrosetae on tibia IV; or if only one, then with one short macroseta on metatarsi I and II .......... 125

118a Palpal patella with a ventral distal process .......... 119
118b Process absent .......... 120

119a With spines around edge of carapace (Fig. 169) .......... *Erigone dentigera* **O.P.-Cambridge**
119b Without spines .......... *Erigone autumnalis* **Emerton**

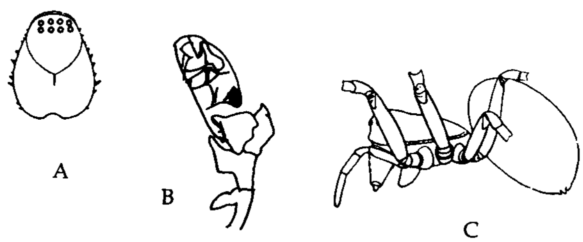



Figure 169. *Erigone dentigera* O.P.-Cambridge; A: carapace of male, B: palp, C: lateral view of female.

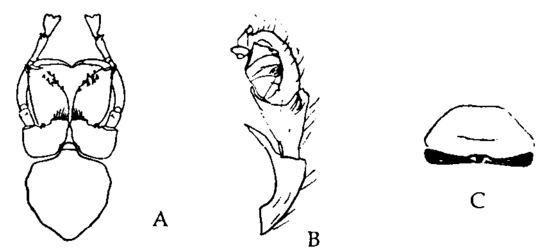



Figure 170. *Erigone autumnalis* Emerton; A: mouthparts of male, B: palp, C: epigynum.

120a Cephalic lobes present .......... 121
120b Cephalic lobes absent .......... 123

121a Cephalic lobe in males in the shape of a horn; abdominal pattern distinct (Fig. 171) .......... *Grammonota texana* **(Banks)**
121b Horn absent in males; abdominal pattern not as above .......... 122

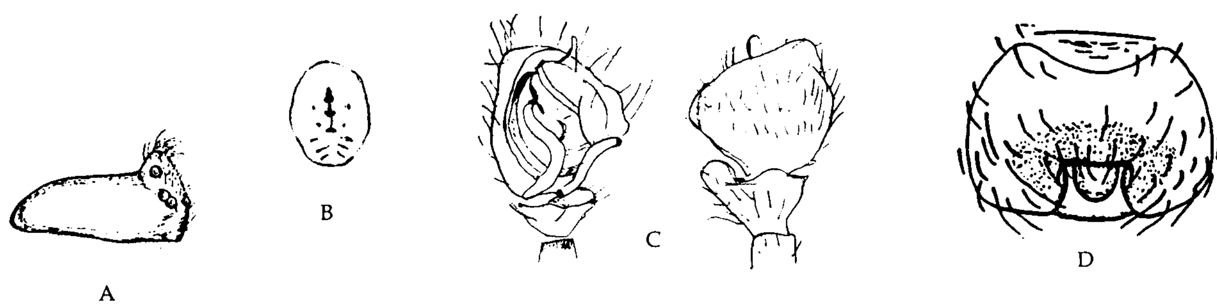



Figure 171. *Grammonota texana* (Banks); A: lateral view of male carapace, B: abdominal pattern, C: palp (meso-ventral, dorsal views), D: epigynum.

122a Cephalic pits present; spines around edge of carapace (Fig. 172) .......... *Ceratinops* **spp.**
122b Cephalic pits absent; spines absent (Fig. 173) .......... *Ceraticelus* **spp.**

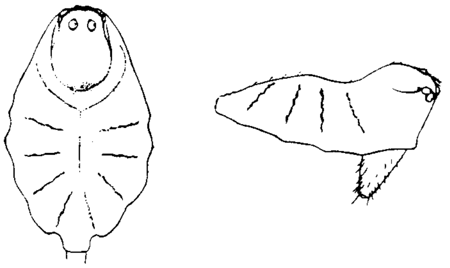


Figure 172. *Ceratinops* spp.; carapace of male (dorsal, lateral views).

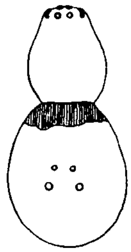


Figure 173. Dorsum of *Ceraticelus* spp.

123a Orange hue; scutum on abdomen (Fig. 174) .......... *Ceratinopsis* **spp.**
123b Darker in color; scutum absent .......... 124

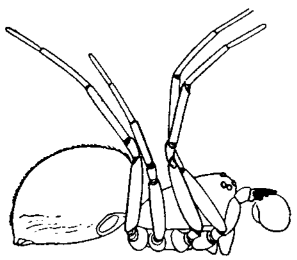


Figure 174. Lateral view of *Ceratinopsis* spp.

124a Promargin of chelicerae with a vertical row of teeth along lateral margin; abdomen yellow to gray .......... *Eperigone eschatologica* **(Crosby)**
124b Spines absent; abdomen dark gray to black .......... *Walckenaeria spiralis* **(Emerton)**

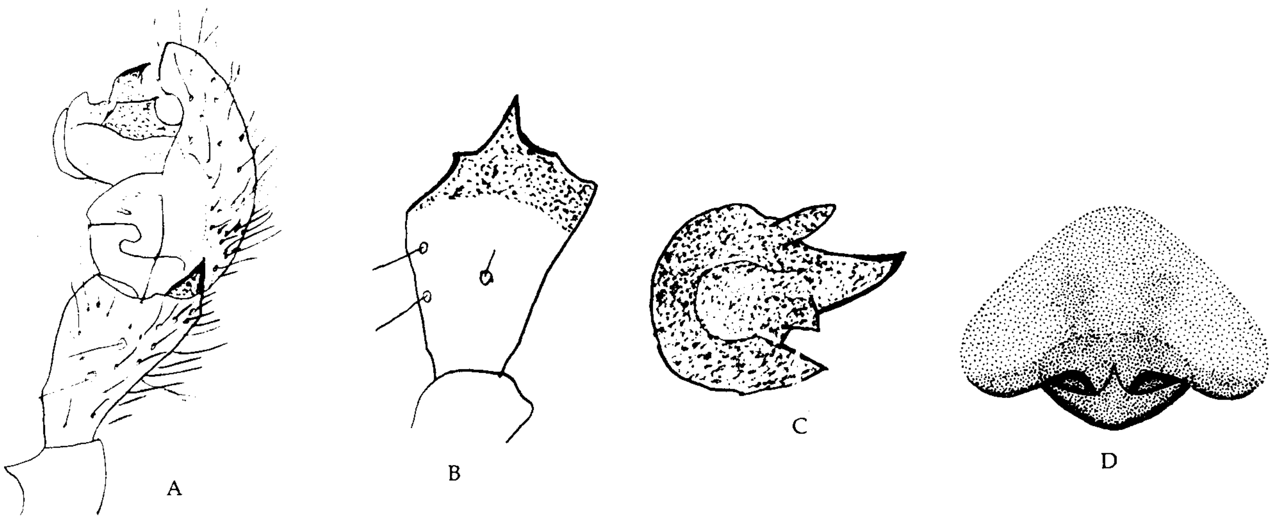



Figure 175. *Eperigone eschatologica* (Crosby); A: palp (ectal view), B: palpal tibia (dorsal view), C: embolic division of palp, D: epigynum.

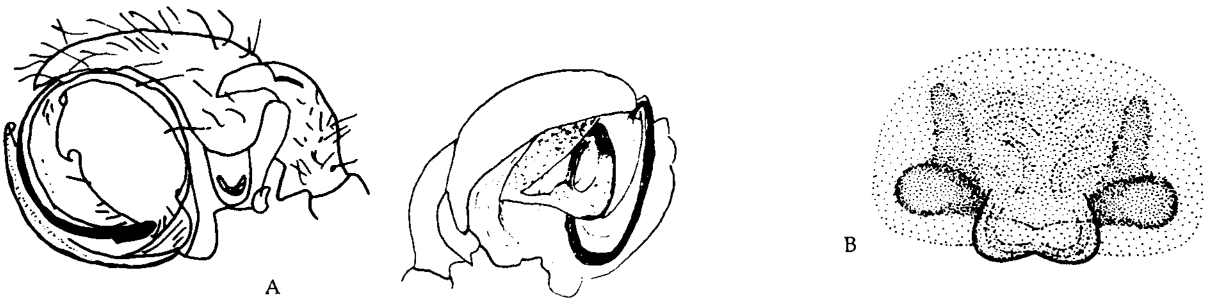


Figure 176. *Walckenaeria spiralis* (Emerton); A: palp (ectal, mesal views), B: epigynum.

125a Spiracular opening very wide and advanced 1/3 of distance forward to epigastric spiracle .......................................................................................................................................................... *Tennesseellum formicum* **(Emerton)**
125b Spiracular opening near spinnerets .......................................................................................................................... 126

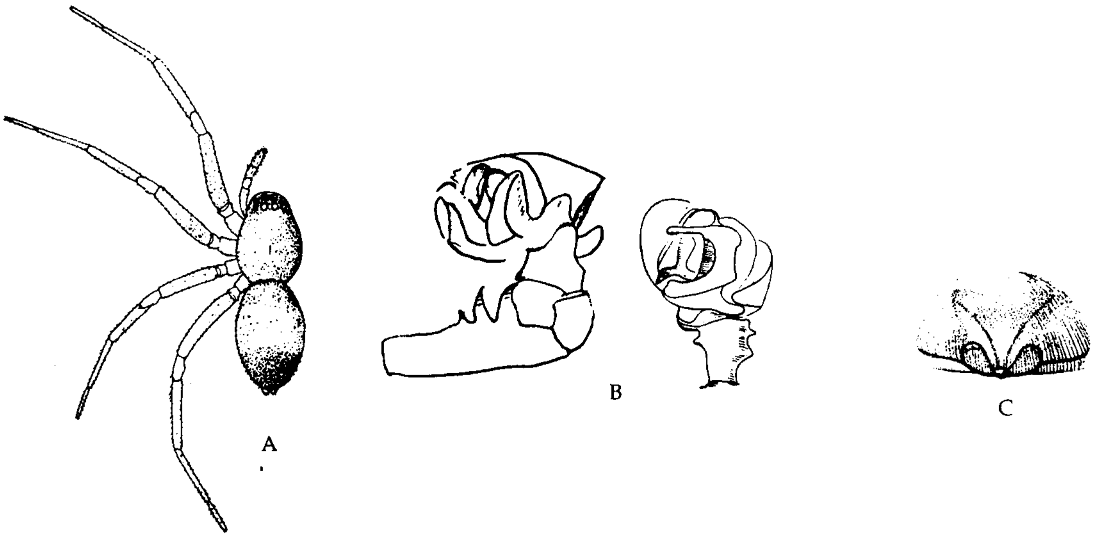


Figure 177. *Tennesseellum formicum* (Emerton); A: dorsum of female, B: palp (ventral, lateral views), C: epigynum.

126a Abdomen with central, broad longitudinal black band and white markings on side (Fig. 178) .................................................................................................................................. *Frontinella pyramitela* **(Walckenaer)**
126b Abdomen with a broad transverse light dorsal band (Fig. 179) .......................................................... *Meioneta* **spp.**

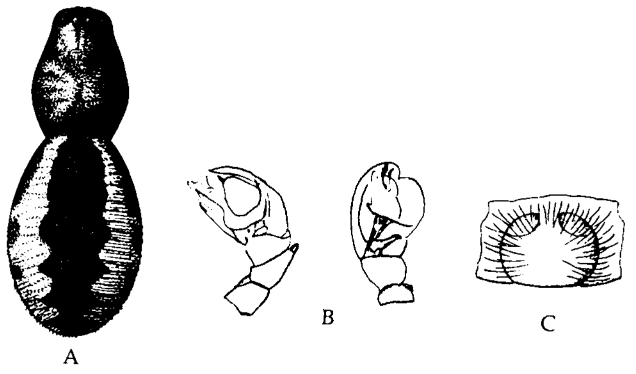



Figure 178. *Frontinella pyramitela* (Walckenaer); A: dorsum of female, B: palp (ventral, lateral views), C: epigynum.

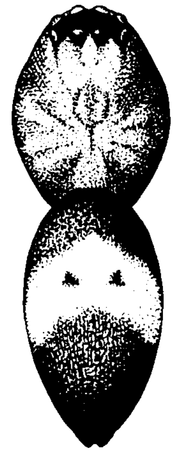


Figure 179. Dorsum of male *Meioneta* spp.

**Table 1. Spiders collected by D-Vac in cotton over several years. Figures are the mean number of spiders per meter of cotton row.[a]**

| | 1978[b] | 1979[b] | 1980[b] | 1981[b] | 1985[c] | 1986[d] | 1987[d] | 1989[e] | Mean |
|---|---|---|---|---|---|---|---|---|---|
| ANYPHAENIDAE | | | | | | | | | |
| *Aysha gracilis* | 0 | 0.008 | 0 | 0.077 | 0.065 | 0.004 | 0.021 | 0.058 | 0.029 |
| ARANEIDAE | | | | | | | | | |
| *Acanthepeira stellata* | 0.067 | 0.076 | 0.029 | 0.323 | 0.086 | 0 | 0 | 0 | 0.073 |
| *Cyclosa turbinata* | 0 | 0.012 | 0.004 | 0.049 | 0.012 | 0.013 | 0.043 | 0 | 0.017 |
| *Neoscona arabesca* | 0 | 0 | 0.004 | 0.02 | 0.003 | 0.004 | 0.043 | 0.004 | 0.01 |
| CLUBIONIDAE | | | | | | | | | |
| *Cheiracanthium inclusum* | 0.018 | 0.032 | 0.091 | 0.103 | 0.031 | 0 | 0.04 | 0.004 | 0.04 |
| DICTYNIDAE | | | | | | | | | |
| *Dictyna* spp. | 0 | 0.032 | 0.094 | 0.146 | 0.089 | 0.347 | 0.172 | 0.103 | 0.123 |
| OXYOPIDAE | | | | | | | | | |
| *Oxyopes salticus* | 0.942 | 0.524 | 0.931 | 0.603 | 1.908 | 1.027 | 1.268 | 1.302 | 1.06 |
| *Peucetia viridans* | 0.004 | 0 | 0.178 | 0.011 | 0.009 | 0.004 | 0.037 | 0.004 | 0.031 |
| SALTICIDAE | | | | | | | | | |
| *Habronattus coecatus* | 0 | 0.004 | 0.051 | 0.014 | 0 | 0 | 0 | 0.009 | 0.01 |
| *Hentzia palmarum* | 0.004 | 0 | 0.022 | 0.009 | 0.003 | 0.049 | 0.04 | 0.027 | 0.019 |
| *Metaphidippus galathea* | 0 | 0.004 | 0.076 | 0.02 | 0.015 | 0.124 | 0.181 | 0.018 | 0.055 |
| *Phidippus audax* | 0.031 | 0.008 | 0.164 | 0.049 | 0.049 | 0.04 | 0.055 | 0.022 | 0.052 |
| TETRAGNATHIDAE | | | | | | | | | |
| *Tetragnatha laboriosa* | 0 | 0.244 | 0.036 | 0.289 | 0.061 | 0.027 | 0.043 | 0.071 | 0.096 |
| THERIDIIDAE | | | | | | | | | |
| *Latrodectus mactans* | 0 | 0.004 | 0.011 | 0.011 | 0.025 | 0 | 0 | 0 | 0.006 |
| THOMISIDAE | | | | | | | | | |
| *Misumenops* spp. | 0.107 | 0.044 | 0.164 | 0.129 | 0.08 | 0.124 | 0.08 | 0.234 | 0.12 |
| Other spiders | 0.64 | 0.776 | 0.621 | 1.341 | 0.404 | 0.805 | 1.144 | 0.415 | 0.768 |
| Total spiders | 1.813 | 1.768 | 2.476 | 3.194 | 2.84 | 2.568 | 3.167 | 2.271 | 2.51 |
| Total no. weeks | 9 | 10 | 11 | 14 | 13 | 9 | 13 | 9 | |
| Sampling period | 5/25 to 6/28 | 7/5 to 9/11 | 6/12 to 8/18 | 5/19 to 8/24 | 6/14 to 9/4 | 6/5 to 7/31 | 5/21 to 8/20 | 5/12 to 7/14 | |

[a] Data courtesy of W. L. Sterling

[b] Ellis Prison Unit

[c] Austonio

[d] Brazos Bottom

[e] Snook

**Table 2. Spiders sampled by whole plant technique (no./meter), Ellis prison Unit.[a]**

| | 1978 | 1979 | 1980 | 1981 | Mean |
|---|---|---|---|---|---|
| ANYPHAENIDAE | | | | | |
| *Aysha gracilis* | 0.091 | 0.058 | 0.05 | 0.263 | 0.115 |
| ARANEIDAE | | | | | |
| *Acanthepeira stellata* | 0.091 | 0.261 | 0.007 | 0.217 | 0.144 |
| *Cyclosa turbinata* | 0.007 | 0.196 | 0.025 | 0.137 | 0.091 |
| *Mangora gibborosa* | 0 | 0.015 | 0.004 | 0.02 | 0.01 |
| *Mecynogea lemniscata* | 0 | 0.008 | 0.007 | 0.007 | 0.005 |
| *Neoscona arabesca* | 0.013 | 0.081 | 0.018 | 0.067 | 0.045 |
| CLUBIONIDAE | | | | | |
| *Cheiracanthium inclusum* | 0.249 | 0.104 | 0.121 | 0.143 | 0.154 |
| DICTYNIDAE | | | | | |
| *Dictyna segregata* | 0.021 | 0.1 | 0.125 | 0.237 | 0.121 |
| LINYPHIIDAE | | | | | |
| *Grammonota texana* | 0.006 | 0 | 0.007 | 0.007 | 0.005 |
| LYCOSIDAE | | | | | |
| *Pardosa* spp. | 0.006 | 0.188 | 0.057 | 0.237 | 0.122 |
| *Schizocosa avida* | 0.003 | 0.008 | 0.004 | 0.01 | 0.006 |
| OXYOPIDAE | | | | | |
| *Oxyopes salticus* | 0.671 | 0.315 | 0.196 | 0.143 | 0.331 |
| *Peucetia viridans* | 0.01 | 0.015 | 0.136 | 0.037 | 0.049 |
| PHILODROMIDAE | | | | | |
| *Philodromus* spp. | 0 | 0.004 | 0.004 | 0.01 | 0.004 |
| SALTICIDAE | | | | | |
| *Habronattus coecatus* | 0 | 0.008 | 0.039 | 0.007 | 0.013 |
| *Hentzia palmarum* | 0.014 | 0.046 | 0.007 | 0.01 | 0.019 |
| *Metaphidippus galathea* | 0.051 | 0.011 | 0.068 | 0.017 | 0.037 |
| *Phidippus audax* | 0.214 | 0.031 | 0.168 | 0.073 | 0.121 |
| TETRAGNATHIDAE | | | | | |
| *Tetragnatha laboriosa* | 0 | 0.4 | 0 | 0.107 | 0.127 |
| THERIDIIDAE | | | | | |
| *Achaearanea globosa* | 0.007 | 0.004 | 0 | 0.003 | 0.003 |
| *Argyrodes trigonum* | 0.014 | 0.023 | 0 | 0.007 | 0.011 |
| *Latrodectus mactans* | 0.007 | 0.027 | 0.011 | 0.03 | 0.019 |
| *Theridion* spp. | 0 | 0.035 | 0.014 | 0.117 | 0.041 |
| THOMISIDAE | | | | | |
| *Misumenoides formosipes* | 0.003 | 0 | 0.011 | 0.007 | 0.005 |
| *Misumenops* spp. | 0.243 | 0.104 | 0.175 | 0.057 | 0.145 |
| *Xysticus* spp. | 0.021 | 0.008 | 0.014 | 0.017 | 0.015 |
| ULOBORIDAE | | | | | |
| *Uloborus glomosus* | 0 | 0.019 | 0.007 | 0.017 | 0.011 |
| Other spiders | 0.524 | 0.593 | 0.364 | 0.409 | 0.472 |
| Total spiders | 2.266 | 2.662 | 1.639 | 2.413 | 2.245 |
| Total no. weeks | 14 | 13 | 14 | 15 | |
| Rainfall (cm) | 12.83 | 53.09 | 12.7 | 48.51 | |
| Sampling period | 5/9 to 8/9 | 7/2 to 10/3 | 5/23 to 8/20 | 5/12 to 8/25 | |

[a]Data courtesy of W. L. Sterling.

**Table 3. Total number of spiders collected by pitfall traps.[a]**

| | 1978[b] | 1979[b] | 1980[b] | 1981[b] | 1985[c] | 1988[d] | 1989[d] | Total |
|---|---|---|---|---|---|---|---|---|
| ANYPHAENIDAE | | | | | | | | |
| *Aysha gracilis* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| *Wulfila saltabundus* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| ARANEIDAE | | | | | | | | |
| *Acanthepeira stellata* | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 4 |
| *Cyclosa turbinata* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| *Gea heptagon* | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 4 |
| CLUBIONIDAE | | | | | | | | |
| *Castianeira* spp. | 2 | 0 | 1 | 0 | 0 | 2 | 0 | 5 |
| *Cheiracanthium inclusum* | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| *Clubiona abboti* | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| *Phrurotimpus* sp. | 0 | 0 | 0 | 0 | 29 | 21 | 7 | 57 |
| *Trachelas deceptus* | 3 | 0 | 1 | 4 | 0 | 0 | 0 | 8 |
| DICTYNIDAE | | | | | | | | |
| *Dictyna segregata* | 11 | 10 | 54 | 15 | 41 | 38 | 28 | 197 |
| GNAPHOSIDAE | | | | | | | | |
| *Drassyllus inanus* | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 20 |
| *Drassyllus notonus* | 4 | 2 | 25 | 15 | 0 | 6 | 3 | 55 |
| *Gnaphosa altudona* | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 |
| *Gnaphosa sericata* | 3 | 0 | 7 | 1 | 1 | 0 | 0 | 12 |
| *Synaphosus paludis* | 0 | 1 | 0 | 0 | 4 | 1 | 0 | 6 |
| *Talanites captiosus* | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 |
| HAHNIIDAE | | | | | | | | |
| *Neoantistea mulaiki* | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 6 |
| LINYPHIIDAE | | | | | | | | |
| *Eperigone eschatologica* | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 6 |
| *Erigone autumnalis* | 10 | 5 | 11 | 6 | 11 | 6 | 6 | 55 |
| *Meioneta* spp. | 0 | 0 | 0 | 3 | 0 | 1 | 3 | 7 |
| *Tennesseellum formicum* | 0 | 0 | 0 | 0 | 3 | 2 | 1 | 6 |
| LYCOSIDAE | | | | | | | | |
| *Allocosa absoluta* | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Hogna antelucana* | 2 | 0 | 0 | 0 | 17 | 4 | 4 | 27 |
| *Hogna helluo* group | 2 | 1 | 0 | 3 | 0 | 0 | 0 | 6 |
| *Pardosa atlantica* | 0 | 0 | 0 | 0 | 10 | 2 | 0 | 12 |
| *Pardosa delicatula* | 10 | 3 | 1 | 0 | 14 | 0 | 6 | 34 |
| *Pardosa milvina* | 24 | 33 | 63 | 74 | 6 | 0 | 1 | 201 |
| *Pardosa pauxilla* | 5 | 26 | 75 | 6 | 104 | 1 | 4 | 221 |
| *Pirata davisi* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| *Pirata seminola* | 3 | 6 | 9 | 0 | 0 | 0 | 0 | 18 |
| *Rabidosa rabida* | 3 | 0 | 5 | 1 | 4 | 1 | 0 | 14 |
| *Schizocosa avida* | 4 | 17 | 61 | 47 | 58 | 54 | 28 | 269 |
| *Varacosa acompa* | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 3 |
| Other lycosids | 31 | 26 | 80 | 79 | 89 | 17 | 27 | 349 |
| MIMETIDAE | | | | | | | | |
| *Ero* sp. | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| *Mimetus hesperus* | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| MITURGIDAE | | | | | | | | |
| *Teminius affinis* | 1 | 3 | 1 | 2 | 1 | 5 | 1 | 14 |
| MYSMENIDAE | | | | | | | | |
| *Calodipoena incredula* | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 4 |
| NESTICIDAE | | | | | | | | |
| *Eidmannella pallida* | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 |

**Table 3. Continued.**

| | 1978[b] | 1979[b] | 1980[b] | 1981[b] | 1985[c] | 1988[d] | 1989[d] | Total |
|---|---|---|---|---|---|---|---|---|
| OXYOPIDAE | | | | | | | | |
| *Oxyopes apollo* | 0 | 2 | 2 | 1 | 1 | 3 | 0 | 9 |
| *Oxyopes salticus* | 15 | 4 | 31 | 14 | 94 | 24 | 4 | 186 |
| PHILODROMIDAE | | | | | | | | |
| *Ebo* sp. | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| *Thanatus formicinus* | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| PISAURIDAE | | | | | | | | |
| *Dolomedes triton* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| SALTICIDAE | | | | | | | | |
| *Eris militaris* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| *Habronattus coecatus* | 15 | 3 | 25 | 5 | 5 | 4 | 4 | 61 |
| *Metaphidippus galathea* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| *Phidippus audax* | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 |
| TETRAGNATHIDAE | | | | | | | | |
| *Glenognatha foxi* | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 4 |
| *Tetragnatha laboriosa* | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| THERIDIIDAE | | | | | | | | |
| *Latrodectus mactans* | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 6 |
| THOMISIDAE | | | | | | | | |
| *Misumenops* spp. | 1 | 0 | 2 | 0 | 1 | 2 | 0 | 6 |
| *Xysticus* spp. | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 4 |
| Other spiders | 10 | 25 | 10 | 11 | 14 | 15 | 8 | 93 |
| Total spiders | 174 | 168 | 479 | 299 | 540 | 217 | 146 | 2023 |
| Total no. weeks | 13 | 12 | 15 | 16 | 13 | 6 | 13 | |
| No./week | 13.4 | 14 | 31.9 | 18.7 | 41.6 | 36.3 | 11.1 | |
| Total no. trap samples | 70 | 72 | 82 | 96 | 96 | 60 | 130 | |
| No./trap | 2.5 | 2.3 | 5.8 | 3.1 | 5.6 | 3.6 | 1.1 | |
| Rainfall (cm) | 12.83 | 53.09 | 12.7 | 48.51 | ca. 13 | 7.1 | 21.9 | |
| Sampling period | 5/9 to 8/9 | 6/25 to 10/3 | 5/23 to 8/20 | 4/29 to 8/24 | 6/5 to 9/13 | 6/20 to 8/15 | 5/8 to 7/31 | |

[a] Data courtesy of W. L. Sterling
[b] Ellis
[c] Austonio
[d] Snook

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