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Biology of the Rosaceae Branch Borer, *Osphranteria coerulescens* (Coleoptera: Cerambycidae)[1]

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ABSTRACT

Osphranteria coerulescens Redtenbacher causes extensive damage to living rosaceous trees in Iran. The adults are redescribed and the larva and pupa are described. Details of mating behavior, oviposition, fecundity, behavior of immatures, and nature and extent of damage caused are given.

Adults are active from late May to mid-June. In the field, females prefer spring twigs for oviposition. The larva requires 11 months to develop and the pupa completes development in 22–24 days.

Damage by the beetles is readily apparent when the tips of infested twigs break off and larger branches break off as larval boring proceeds. A heavy infestation of *O. coerulescens* results in significant crop reduction.

Osphranteria coerulescens Redtenbacher is a destructive pest of fruit trees and roses in Iran. Although its presence in Iran and Afghanistan has been confirmed by Balachowsky (1962), no extensive research has been done on its biology and control. In view of the economic importance of this beetle, an intensive study of its biology, distribution, and the damage it causes has been made.

Observations made over a period of 12 years, particularly in the recent intensive 2-year study, have shown that this pest attacks such fruit trees as almond, wild almond, apricot, peach, cherry, black cherry, prune, plum, apple, quince, and pear. Grafted and wild roses are also damaged. Because all of these hosts belong to the family Rosaceae, we propose the common name, the Rosaceae branch borer, for *O. coerulescens*.

This species has been observed on various fruit trees in the following provinces of Iran: Tehran and vicinity, Kazvin, Isfahan (Najaf-abad, Homayoon-shahr, Margh, Ghazanfarieh, Abshirin, Mahyar, Shahreza), and Fars (Shiraz, Persepolis, Marvdasht, Firuzabad, Estahbanat, Ardekan). In addition, it has been recorded from Bandar-abbas, Baftan, Kahan, and areas between Suse and Isfahan and Sarbaz (Villiers 1967). The beetle has been recorded from Afghanistan but not from Russian Central Asia, where it is likely to be present (Balachowsky 1962).

O. coerulescens belongs to the tribe Callichromini. Knowledge of the habits of members of the Callichromini is fragmentary and the biologies of very few species are known. Linsley and Hurd (1959) reported on the North American *Plinthocoelium suaveolens plicatum* (LeConte), and Duffy (1953, 1957, 1960) summarized the knowledge of several European, African, and Neotropical species: *Aromia moschata* (L.), *Philematium* spp., and *Callichroma* spp.

The genus *Osphranteria* contains 3 species, all described from Iran. These are *O. coerulescens*, *O. suaveolens* Redtenbacher and *O. richteri* Heyrovsky. As there is almost no detailed information published on characteristics of *O. coerulescens*, especially on larva and pupa, an attempt was made to redescribe the adults and describe the larva and pupa. Descriptions for comparison are unavailable for the other 2 species of the genus. A search was

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made in the study area for those species and their hosts, but none was found. A characterization of *O. coerulescens* follows.

DESCRIPTIONS

Male. (Fig. 1, A).—Moderate-sized; integument shiny, violaceous to piceous, elytra densely clothed with appressed golden pubescence. Head with front deeply grooved, irregularly, deeply punctate; antennal tubercles prominent, obtuse; mandibles stout, suddenly curved toward apex, apex acute; palpi unequal in length, apical segments slightly dilated; eyes finely faceted, deeply emarginate; vertex impressed behind antennal tubercles, surface scabrous; antennae slender, slightly longer than body, scape short, conical, segments from 3rd carinate, 3rd segment much longer than 4th, 4th equal to 5th, remaining segments gradually decreasing in length. Pronotum broader than long, sides rounded, unarmed; disc convex with a median, lyre-shaped, confluently punctate, shiny area, sides finely rugose, subopaque; median area densely clothed with short, golden, appressed pubescence; prosternum punctate like sides except for shiny apical area; meso- and metasternum minutely, very densely punctate, densely clothed with pale appressed pubescence. Elytra almost 3 times as long as broad, sides tapering apically; disc with surface obscured by fine, very dense, short, golden, appressed pubescence which obscures the surface; apices narrowly rounded. Legs slender, elongate, hind tibiae flattened. Abdomen very finely punctate and densely pubescent except on apices of sternites; apex of last sternite broadly emarginate. Length, 16–22 mm.

Female.—Similar in shape and size. Pronotum without a lyre-shaped discal area. Elytra finely clothed with dark appressed pubescence, surface not obscured. Abdomen with apex of last sternite notched medially. Length, 16–22 mm.

Type-Locality.—South Persia.

Range.—Southern Iran, Kurdistan, Syria.

Mature Larva.—Slender, dirty yellowish. Head smooth, sides rounded; frontal sutures indistinct, median suture well defined. Labrum slightly oblong-circular. Mandibles short, robust, basal portions pale. Antennae prominent, apical segment slender, preapical segment setose. One ocellus present at each side ventrad from antenna. Maxillae with apical segments of palpi about as long as 2nd segments, lobes conspicuously clothed with rather long, erect setae. Labium with numerous, long, erect setae. Hypostoma with front and lateral margins dark. Gula broad, sutures distinct. Sides with several long erect setae at apical third. Prothorax clothed with numerous, long, suberect setae. Pronotum rectangular, whitish, shiny; surface finely rugose, sides at base with a few erect setae. Abdomen with dorsal ampullae marked by a deep longitudinal furrow at outside third and a shallow transverse furrow across apical third, surface with shallow whorls. Anal lobes smooth, with numerous erect setae. Pleural discs distinct, setose. Legs 3-segmented, longer than maxillary palpi, claws not strongly sclerotized. Spiracles ovoid, peritreme thin. Length, up to 30 mm.

Pupa.—Head totally concealed from above, elongate, triangular; vertex convex, smooth, glabrous; front glabrous, rugulose; clypeus impressed, glabrous; maxillary palpi stout. Antennae extending to about 4th abdominal segment, then recurving ventrally. Pronotum with sides rounded, apical margin slightly produced medially or shallowly emarginate; surface glabrous, rugulose; mesonotum with a few short setae, scutellum with apex narrowly

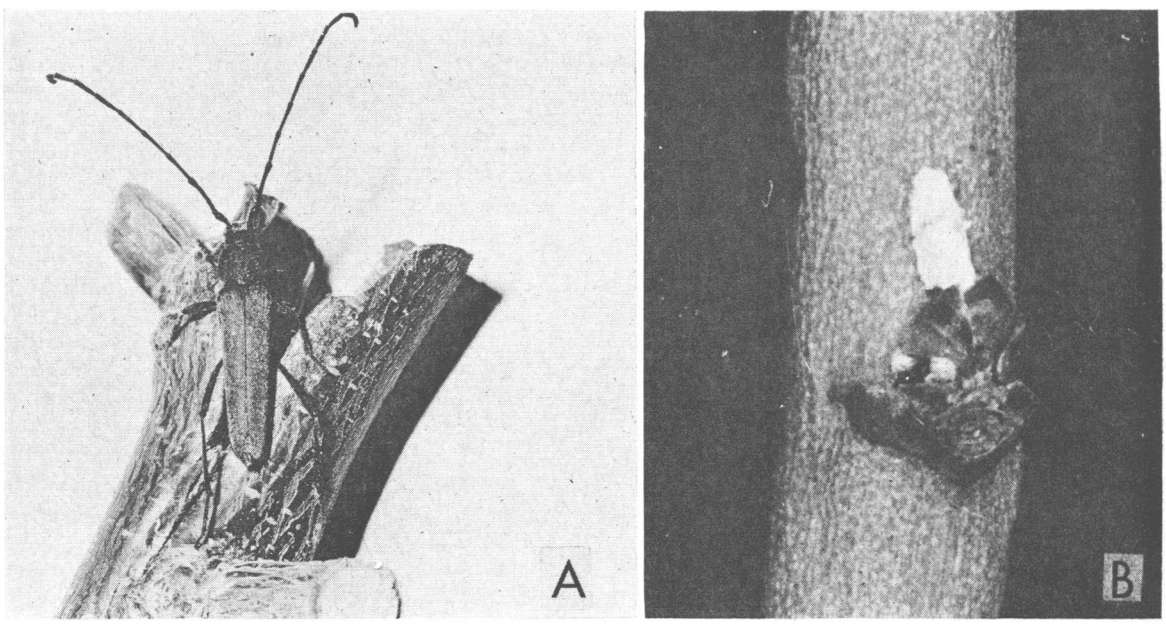

FIG. 1A.—Male adult of *O. coerulescens*. B.—Egg of *O. coerulescens* deposited at the inner angle between the bud and twig of almond.

rounded, surface transversely rugose; metanotum glabrous, transversely striate, scutellar groove shallow. Elytra extending to 3rd abdominal segment. Abdomen with tergites 1–6 with paired, transversely oval groups of short spicules which are inclined backward. Tergite 7 elongate, broadly V-shaped bearing spicules toward posterior end. Tergite 8 rounded behind, vaguely, minutely setose. Tergite 9 retracted behind 8, not setose. Legs extending to 5th abdominal tergite. Spiracles present on first 8 abdominal segments, peritreme raised above surface. Length, up to 25 mm.

ADULT BEHAVIOR

Observations on *O. coerulescens* in Shiraz revealed that the adults are active between late May and mid-June. All adult specimens studied (over 150) were collected from branches and leaves of rosaceous plants.

Mating.—Adults, upon emergence from their pupal chamber, walked a short distance, made a few short flights, and were capable of mating. Females removed from pupal chambers 3–4 days before normal emergence (prior to darkening of pupa) could receive males. To determine whether the insects feed before mating, a sugar-saturated piece of cotton was made available in the rearing cages. Most of the adults moved toward the feeding dish. Others showed no inclination to feed, but when they were placed at the food source, they readily accepted the sugar solution. Mating behavior was observed on freshly emerged and fed specimens in 10×6×3-cm cardboard containers with glass lids.

After the first contact with a female, the male became stimulated and initiated a quick searching behavior until the female was again contacted. The male mounted the female with the front and middle legs around her pro- and mesothorax and the hind legs on the surface or not in contact and in the air. The male immediately began to "lick" the front margins of the female's pronotum and attempted to join by arching the end of his abdomen. The phallus was forced between the apical abdominal sclerites of the female and coupled with her genitalia. While joined, the male continued palpating the pronotum, scutellum, and basal area of the female elytra and slid his abdomen over her elytra at a rate of 40–60 to-and-fro motions/min. The male's antennae moved forward and backward during mating. Similar behavior has been recorded for species in other groups of Cerambycidae by Michelsen (1963, 1966) and Chemsak and Powell (1966). Near the termination of the mating act, the movements of the male's antennae, palpi, and abdomen became gradually slower and irregular until they ceased. The end of copulation was clearly evident by the peculiar tremor of the male antennae.

After copulation, the female gave a violent shake, causing the male to dismount. The male remained motionless on the female's back for some time in a few cases. Occasionally the male attempted to mate again shortly, but most pairs separated after the 1st mating and made no attempts to resume activity. On the basis of observations made on 2 ♂ which had mated 5 and 6 times, it is evident that individuals are capable of frequent encounters. Also, 1 ♂ will mate with different females and a female will accept different males. Mating time (the period from mounting to cessation) varied from 3 to 28 min (mean 18 min).

Oviposition.—After mating, the female passed a period of 5 hr to 2 days (mean 1.5 days) before ovipositing. When a suitable niche on the branches was found, she moved to-and-fro 15–20 times, rubbing the underside of her body on the stem. The ovipositor, which is 2–3 mm long, was extruded and a glutinous secretion sprayed on the area. The egg was laid immediately on the secretion. Selection of an oviposition spot depended upon several factors, and was studied in the laboratory and in an orchard.

In the Laboratory.—Screened rearing boxes, 34×27 cm, were used for this purpose. To facilitate the movement of the insects inside the boxes, the floors were covered with thick paper. Sugar water was provided in a small container with a cotton wick. Three almond twigs (30 cm long) with leaves were placed in each cage. Two additional twigs were also added, one cut a year earlier and the other cut a few days before. Ten replicate boxes of this type were prepared and a recently mated pair was introduced into each.

Observations revealed that females preferred fresh twigs for oviposition. The favored site for egg deposition was the angle between the petiole and stem (Fig. 1 B). Eggs were also laid on the twig surface and usually singly but occasionally in groups of 2 or 3.

In the Orchard.—Ten almond trees were selected and pruned to limit surface area, but an attempt was made to retain the original shape of the tree. Cylindrical iron frames were placed around the trees and covered with nylon mosquito netting. The cages thus formed were 200 cm high and 120 cm diam. One freshly emerged, mated female was placed on each tree.

We found that spring twigs were preferred for oviposition, particularly at the inside corner between the twig and petiole. Our observations on 52 branches on 10 almond trees indicated that females lay their eggs singly, primarily on twigs 2–5 mm diam, between 4 and 30 cm below the tips of the twigs. Apparently the area more than 30 cm below the twig tip is difficult for the larvae to bore into. Also, because the larvae usually burrow upward for ca. 2.5 cm after penetrating, eggs are very seldom laid at the tip of the branches.

Fecundity.—Investigations to determine the fecundity of *O. coerulescens* were carried out in the field and in the laboratory. However, because accurate counts of eggs on orchard trees were very difficult to make, laboratory results are given. The investigations were conducted at 30±4°C and 26±5% RH, with 10 mated pairs of beetles, each pair in a separate rearing cage. A freshly cut almond branch

placed in water was put in each cage. The number of eggs deposited was counted twice a day. Oviposition occurred between the 1st and 13th days after mating. Most of the eggs were laid within the first 8 days with the maximum on the 5th day. Three of the females died before ovipositing, but the remaining seven laid 30–75 eggs each (mean 51.7).

EGG, LARVA, AND PUPA

Incubation Period.—Eggs obtained in the laboratory were used to determine the incubation period and also to observe color changes. Freshly laid eggs were orange, with a glossy enameled coating. The orange faded away and the egg gradually turned white. A rough estimate of the age of an egg and approximate date of hatching could be made by careful observation of the color changes. These color changes also occurred in eggs from the field.

The incubation period ranged from 7 to 11 days, with an average of 9 days at 30±4°C and 26±5% RH. This period is shorter than the 2–3 weeks reported by Linsley (1961) for most Cerambycidae. The short incubation period in *O. coerulescens* may be a result of the high temperature and rather low relative humidity in the tests, or it may be a species characteristic.

Larval Behavior.—When it hatched, the larva entered the branch by boring through the bottom of the egg. Another very small hole was cut in the side of the egg shell, possibly to allow air to enter the egg. The presence of this hole is an aid in determination of the proper time for spraying for newly hatched larvae. In the field, egg shells remained on the trees for 2 weeks or longer.

After it entered the twig, the larva burrowed spirally toward the apex for 2 or 3 cm. This behavior was observed in each of 120 specimens. After ca. 3 weeks, the larva backed down to the point of penetration. Here the burrow was enlarged by alternate up and down boring. A month after it hatched, the larva bored rapidly toward the twig base from the oviposition spot, making an alternately straight and spiral gallery. Boring was continued through summer and the greater part of autumn. During this time the larva left the spring shoots and entered the larger 1½-year-old twigs (Fig. 2 C). On some trees, the larva even bored into the trunk of a 6- to 7-year-old tree with a diameter of from 4 to 5 cm and as a result, the trunk was broken by wind in fall or winter. The larval stage lasted for 11 months and transformation to the pupa occurred in mid-spring.

Pupa.—To study the changes in pupal color and duration of the pupal stage, 24 branch sections containing mature larvae were placed in glass jars covered with gauze and stored at 30±4°C and

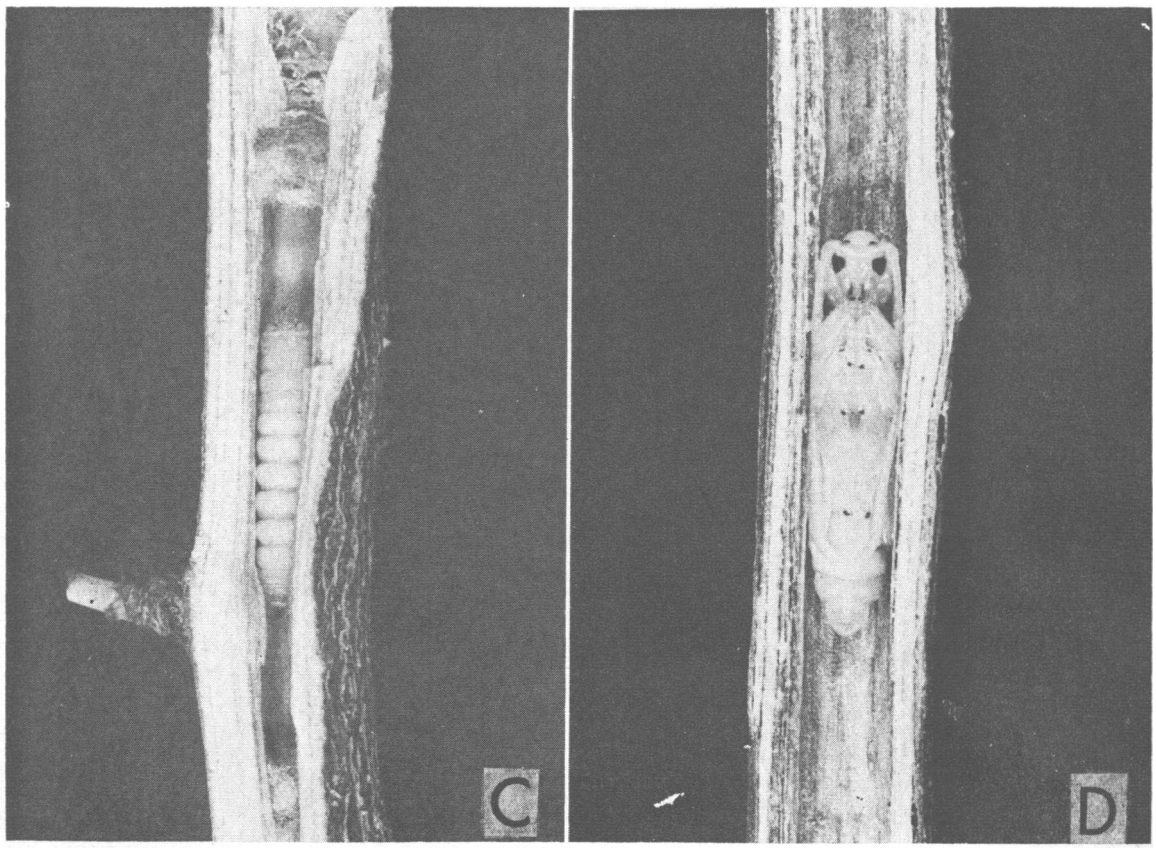

FIG. 2C.—Exposed section of an almond twig showing mature larva and gallery of *O. coerulescens.* D.—Pupa of *O. coerulescens* in almond twig.

FIG. 3E.—Withered leaves of almond indicating a recent attack by larvae of *O. coerulescens* in Shiraz, Iran. F.—Almond tree in Shiraz, Iran, showing heavy infestation by larvae of *O. coerulescens*.

26±5% RH. Before it became a prepupa, each larva cleared the apical end of the larval gallery of frass. This cleared area became the pupal chamber with the basal end plugged by fine, compacted frass and the apical end by moist sawdust. The chambers (Fig. 2 D) were cylindrical with a mean length of 67 and mean diameter of 5 mm (9 samples). During the prepupal stage, activity slackened and the insect became shorter and thicker. The color changed from orange to yellow and the prepupa appeared to be motionless except for some abdominal movements. The duration of the prepupal stage under laboratory conditions was 5–10 days (mean, 7.6 days) for males and 6–13 days (mean, 8 days) for females. The prepupal stage began in early May around Shiraz under natural conditions. The yellowish pupae appeared at the end of prepupal stage, and 4–14 days (mean, 9 days) later, depending on the individual, a pinhead-sized black spot appeared on the eyes. Within 2 days, other black spots appeared on the joints between the tibiae and femora, at the tips of the antennae, and on the tips of the elytra. Two days later the entire body darkened, except for a band on each side of the abdominal segments. These bands remained yellowish until the end of the pupal stage and darkened just prior to adult emergence. The duration of the pupal period ranged from 12 to 17 days (mean 14 days) for males and from 12 to 21 days (mean 15.6 days) for females.

The adults emerged through the apical end of the pupal chambers and became active after the integument hardened. Observations in both the field and laboratory indicate that *O. coerulescens* has 1 annual generation.

NATURE AND EXTENT OF DAMAGE TO HOST PLANTS

The presence of larvae within almond branches is easily detectable. Two weeks after they hatch, larvae have bored into the twigs sufficiently to wither and discolor the leaves (Fig. 3 E). During the short period of movement up the twig, the larva cuts the vascular bundles, reducing the amount of sap at the top of the twig. This activity apparently produces an environment favorable for the development of the larva. After 3 weeks, when the larva has turned and is proceeding toward the base of the twig, the damaged tip of the twig falls off. Badly infested trees are quite obvious after 20–25 days because of the fallen twigs. About 4 weeks after larval entry, the egg shells are no longer present on the twigs, but the larval entrance is marked by a 10–15-mm-long, glutinous filament extruded from the branch at this point. On the trees, the tips of the broken branches are brownish and have irregularly cut surfaces (Fig. 3 F). Twigs containing 4-week-old larvae can be crushed easily at the brownish spot. In addition to the central larval gallery, the branches have small holes to the outside. Fine frass is ejected through these openings.

From the young branches, larvae may continue boring into the trunks of trees 6–7 years old. These branches break off at the slightest pressure and in heavily infested orchards, many may be seen on the ground in late summer, fall, and early spring. This breakage can result in severe crop reduction.

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Chromosome Numbers of the Blattaria[1]

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ABSTRACT

The numbers of chromosomes of 106 species (62 genera) of Blattaria are given; the numbers for 84 species are reported for the first time. The numbers vary greatly in the suborder and range from n ♀ = 8 to n ♀ = 40. Differences in number occur also between species of a given genus. The most frequently occurring haploid number is 19. There is a trend toward higher chromosome numbers in the more recent and highly evolved Blaberidae (ovoviviparous and viviparous species). Submetacentric chromosomes are most commonly encountered, followed in frequency by metacentrics and acrocentrics.

The chromosome numbers of only a few of the more than 4000 species of cockroaches are known. Suomalainen (1946), Piza (1958), Cochran and Ross (1967a, b), and others have reported on chromosome numbers of ca. 20 species of Blattaria. In this paper we report on the chromosome numbers of 106 species of cockroaches, belonging to 62 genera; the numbers for 84 species are given for the 1st time. The results are discussed in relation to McKittrick's (1964) phylogenetic scheme of the Blattaria (Fig. A).

MATERIALS AND METHODS

Late-stage nymphs were injected in the abdomen with from 10 to 100 μliters of 0.05% colcemid, depending upon the size of the nymphs. Injection was done late in the afternoon and the cockroaches were allowed to remain overnight in a glass beaker with food and water. The following morning the gonads were dissected out and placed in a chilled 1% sodium citrate solution for 5 min and then into 1:3 glacial acetic acid:absolute alcohol solution for ca. 1 min. Each gonad was transferred to a drop of 45% acetic acid on a glass slide (Corning no. 2948) and macerated. A coverslip of Corning no. 1 thickness was placed over the drop and the gonad was squashed by placing the slide between 2 pieces of absorbent paper and pressing forcefully down with the thumb. The slides were then treated as follows: 1, placed on ca. 1 in. of finely ground dry ice for ca. 10 min; 2, coverslip flipped off and slide placed in a 1:1 solution of acetic acid:absolute alcohol for 10 min followed by successive immersions in absolute alcohol (5 sec) and 95% alcohol (10 min); 3, air dried; sometimes placed on a hot plate for ca. 1 min. and stained with acetic orcein; 4, immersed in 95% alcohol (5 min), absolute alcohol (1 min), and xylene (5 min); 5, mounted in Zeiss L15 phase-contrast medium.

Chromosome counts were made directly from photographs of metaphase spreads (phase-contrast optics at 400–800×, Polaroid Type 51 or 52 film). If good photographs could not be obtained, counts were made directly from the specimen. When 2 or more chromosomes overlapped, the counting was done first from the photograph and then confirmed by examining the preparation. Ten or more mitotic metaphase counts/sex were made, when possible. However, this goal was often difficult to reach with males, so meiotic figures were used instead.

The photographs of the chromosomes used in Fig. 1–97 were taken at 1000× (Kodak Contrast Process Pan 4×5 sheet film, developed for 4 min at 70°F in Kodak D11) and enlarged to 2000×; the scale indicated with each group of figures = 5μ.

When known, the country of origin of the specimens is given in the explanation of figures. In addition to material collected by one of us (L.M.R.) in

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