SYSTEMATIC AND BIOLOGICAL NOTES ON THE LADY-BIRD BEETLES PREDACIOUS ON THE SAN JOSE SCALE IN KASHMIR WITH DESCRIPTION OF A NEW SPECIES (COLEOPTERA: COCCINELLIDAE).

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CONTENTS.

INTRODUCTION.

Predacious lady-bird beetles (Coccinellidae) play an important role in nature by keeping down the numbers of many noxious insects, such as the green-fly, white-fly, mealy-bugs and scale-insects. Several species of the lady-bird beetles have been employed in the past for regulating insect pests. A more recent example is worthy of note: Vesey-Fitzerald (1953) has described how *Chilocorus nigritus* (Fabr.), introduced from India at the end of 1938 into the Seychelles, has exercised a successful control of the coccids of coconut palms in those islands.

The present paper deals with four species of Coccinellidae which feed upon the San José Scale, *Quadraspidiotus perniciosus* (Comst.), in Kashmir. Besides clarifying the identities of these species, biological and distributional notes have also been added in each case. As the San José Scale is a serious pest of fruit trees in Kashmir and in several other parts of the world, it is hoped that the present account would be of more than local interest.

The author takes this opportunity of recording his sincere thanks to Dr. S. L. Hora, Director of this Survey, for taking interest in this work and for providing facilities for the same.

EARLIER RECORDS OF THE COCCINELLID PREDATORS ON THE SAN JOSÉ SCALE.

The following statement gives a list of the species of Coccinellidae that have been hitherto known to feed upon the San José Scale in different parts of the world. Of the sixteen species recorded there is uncertainty regarding the identity of the host-insect in a couple of cases (No. 13 and 15) only. The majority of species belong to the tribe CHILOCORINI Costa,

which is widely distributed and is well known for its habit of feeding on the scale-insects. The other species are either of Australian or Nearctic origin. The two species of Sticholotini from the Oriental Region recorded here for the first time as predatory on the San José Scale are, therefore, of special interest.

List of COCCINELLIDAE recorded as predators on the San José Scale in different parts of the world.

No.	Name of species.	General distribution.	Country where recorded as predator and the reference.
	Tribe CHILOCORINI Costa, 1849.		
1.	*Chilocorus bijugus*, ssp. *infernalis* Muls.	Palaearctic.	Kashmir (Fotidar, 1941).
2.	*C. bipustulatus* (Linn.) . .	,,	Russia (Popova, 1936), Austria (Fulmek, 1941), Hungary (Janeck, 1941).
3.	*C. kuwanae* Silvestri . . .	,,	Japan (Ishii, 1937).
4.	*C. renipustulatus* (Scriba). .	,,	Russia (Popova, 1936); Japan (Kuwana, 1904).
5.	*C. similis* (Rossi) . . .	,,	France (Feytaud, 1913).
6.	*C. stigma* ? (Say) (=*bivulnerus* Muls.).	Nearctic.	U. S. A. (Parrott, 1914; Alden, 1930).
7.	*Orcus australasiae* (Boisd.) .	Australian.	Australia (Jarvis, 1925).
8.	*O. chalybeus* (Boisd.) .	,,	Australia (Jarvis, 1925).
9.	*Exochomus quadripustulatus* L. .	Palaearctic.	Austria (Fulmek, 1941).
	Tribe PENTILINI Casey, 1899.		
10.	*Pentilia* (=*Microweisea*) *misella* (J. Lec.).	Nearctic.	N. America (Quaintance, 1915).
	Tribe COCCIDULINI Costa, 1849.		
11.	*Rhizobius hirtellus* Crotch. .	Australian.	Queensland (Jarvis, 1925).
12.	*R. ventralis* (Erichs.) .	,,	Queensland (Jarvis, 1925); introduced into U. S. A. (Parrott, 1914).
13.	*Lindorus lophantae* (Blaisd.) .	,,	Introduced into California (Uncertain record; Smith, 1896).
	Tribe SCYMNINI Costa, 1849.		
14.	*Cryptolaemus montrouzieri* Muls.	Australian.	World-wide introduction. Feeding in insectary in Egypt (Hall, 1925).
15.	*Scymnus marginicollis* Mannh. .	Nearctic.	U. S. A. (Uncertain—Smith, 1896).
	Tribe SCYMNILINI Casey, 1899.		
16.	*Scymnillus aterrimus* Horn . .	Nearctic.	Idaho (Wakeland, 1938).

Chilocorus bijugus Mulsant.

hilocorus bijugus Mulsant, 1853. *Ann. Soc. linn. Lyon* (2) **1** : 189, (Type locality : East Indies). Crotch, 1874, *A revision of the coleopterous family Coccinellidae* (London) : 183. Korschefsky, 1932, *Coleopt. Cat., Berl.* **16**, 120, Coccinellidae II : 242.

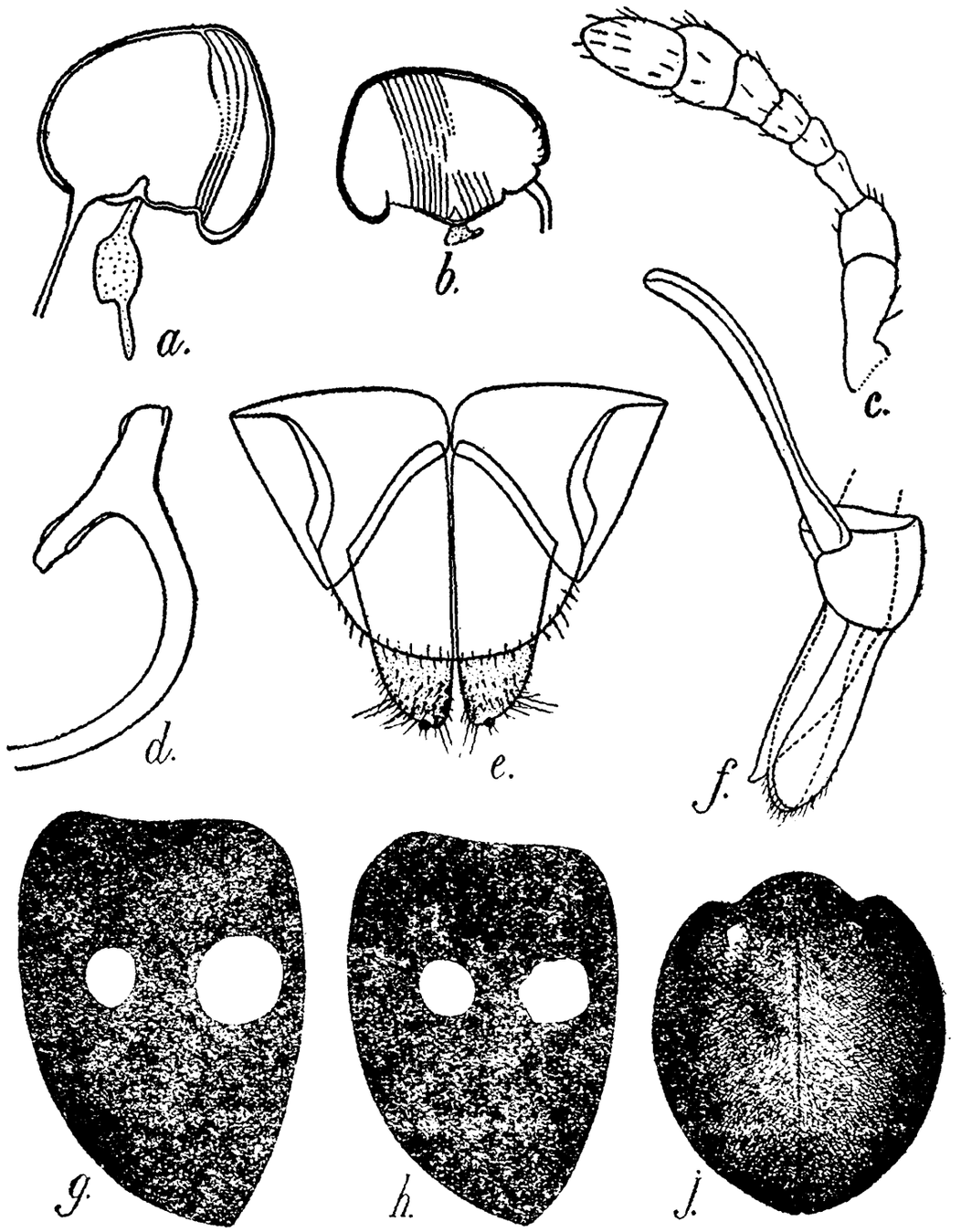
Chilocorus infernalis Mulsant, 1853, *Ann. Soc. linn. Lyon.* (2) **1** : 189—190. (Type locality : North India). Crotch, 1874, *A revision of the coleopterous family Coccinellidae* (London) : 183 (Synonymy).

Chilocorus bijugus sub-sp. *infernalis* Mulsant, Korschefsky, 1932, *Coleopt. Cat., Berl.* **16**, 120, Coccinellidae II : 242. Fotidar, 1941, *Indian Fmg.* **2** (5) : 236.

Body subhemispherical and moderately compressed. Head black on the front except for the greyish eyes and reddish brown labrum. Pronotum and scutellum black and shining, having in certain cases a rather greenish lustre. Elytra of the same colour as the pronotum except for a pair of roundish, testaceous or reddish testaceous spots on each elytron. Both the spots are situated (Text-fig. 1, *g*, *h*) in a transverse line at two-fifths of the length of elytron and are unequal in size, the inner (near the suture) being relatively larger than the outer spot. The diameter of the inner spot in the examples examined, varies between one-third and one-fourths of the greatest width of the elytron. Mulsant (1853) stated that in certain cases it may be even one-sixth of the width. The distance between the suture and the inner spot is equal to the radius of the latter and the distance between the inner and the outer spot is generally equal to the diameter of the former. The size of the outer spot varies, being between three-fifths and three-fourths of the size of the inner spot. Underside black on the thoracic sternites, legs and elytral epipleurae ; the abdominal sternites are reddish testaceous.

Head finely and fairly closely punctate and with short, thin and greyish pubescence. Pronotum strongly arched, narrower anteriorly, anterior emargination deep and subquadrate, lateral and anterior angles rounded, punctation fine and sparse except on the sides where it is coarse and close and is clothed with thin, short and greyish pubescence. Scutellum triangular with the base slightly shorter than the sides and with about four fine punctures in the centre. Elytra with distinct shoulder-boil, slightly expanded near the anterolateral margin ; punctures fine and sparse on the disc and coarse towards the lateral margins. In the female spermatheca is strongly chitinized and compact (Text-fig. 1, *b*) ; the genital plates (ninths sternite) are moderately elongate and the tenth tergite subrounded at the apical margin (Text-fig. 1,*e*).

Length 4·35—5·5. mm. *Width* 4·0—4·9 mm.



TEXT-FIG. 1. *a.*—spermatheca of *Chilocorus rubidus* Hope. *b.*—spermatheca of *C. bijugus* Muls. *c.*—antenna of *C. bijugus*. *d.*—siphonal capsule of *C. rubidus*. *e.*—terminal abdominal segments of ♀ *C. bijugus*. *f.*—male genitalia (except sipho) of *C. rubidus*. *g.* & *h.*—elytral pattern of *C. bijugus*. *j.*—outline of *C. rubidus*.

Biological notes.—Fotidar (1941) recorded *C. bijugus* sub-sp. *infernalis* Mulsant as a predator on the San José Scale in Kashmir. The beetles were observed by the present writer in October 1939 at Tangmarg (7,000-7,500 ft.) on trees infested with the San José Scale, many of which showed signs of attack by the beetles which were, however, not active owing to the cold weather. In the laboratory the beetles fed upon the Scale in large numbers. The beetles were subsequently found at Srinagar and other places, and a study of their life-history made in June-July 1943, yielded the following results.

Eggs were laid freely in captivity on the bark and crevices of the scale-infested twigs, throughout June and July. These were of the usual cigar shape and yellow when freshly laid. In June-July the incubation period was three to four days, the average duration for five batches being 3·4 days. The larvae were predacious, like the adult beetles. There were four larval instars which occupied on an average (based on 10 examples in each case) 4·1, 3·1, 3·0 and 6·1 days respectively. In the last instar, after an active period of three to four days, the larvae ceased feeding and attached themselves to the bark, etc. The pupal stage followed after the last larval moult had been cast ; the duration of the pupal stage varied from six to eight days, the average for ten examples being 7·2 days. The total development period from the egg to the adult stage varied beween 24 and 29 days (average 26·9 days). Since the adults did not lay eggs for a considerable time after emergence, it seemed that in spite of a fairly quick development of the immature stages, the majority of the beetles passed through only one generation a year. Towards the end of summer when their numbers began to increase in the field to make them effective against the pest, the larval and pupal stages were attacked frequently by the Encyrtid *Homalotylus* sp. which was in turn attacked by certain other Chalcid parasites. The adult beetles, however, remained free of the parasite attack and successfully passed through the winter.

Material examined.—INDIA—Kashmir: Tangmarg (7,000-7,500 ft.) predating on the San José Scale, 15.x.1939 (*A. P. Kapur*); Srinagar (5,000 ft.), feeding on the San José scale, 10. iv. 1943 (*A. P. Kapur*). Uttar Pradesh: Kumaon Hills: Almora (5,500 ft.), 2. vii. 1923 (*R. N. Parker*). Assam: Shillong (4,900 ft.), 31.v.1918 (*A.G.R.*).

Remarks.—The type locality for *Chilocorus bijugus* is East Indies while for *S. infernalis* it is North India. Exact localities in these parts were not mentioned by Mulsant in the original descriptions of the species which appear to have been distinguished on minor difference of variable characters such as colour of the body and the size of the elytral spots. Mulsant stated that in *C. bijugus* the inner spot was a little larger than the outer spot and covered about one-sixth to one-third of the elytral width and that the outer spot was nearly one-third, one-fourth and one-sixth of the width. In the case of *C. infernalis* he stated that the inner spot was also larger than the outer spot and was equal to one-sixth to nearly one-third of the width of the elytron and that the outer spot was equal to about three-fifths of the width of the latter. In other words, whereas the outer spot may be smaller or subequal to the inner spot in *bijugus* it was about three-fifths of the size of inner spot in *infernalis*. As has been observed in the description given above, the colour of elytra and the size of spots are variable in the material under report. Crotch (1874) who seems to have seen Mulsant's material, stated that the latter's descriptions referred to the same species. Although the name *bijugus* could claim priority (line) over the name *infernalis*, Crotch retained the latter name without giving any reason for the same. The present observations seem to support Crotch's view that the two names be regarded as synonymous. However, it would be necessary and correct to retain the name *C. bijugus* for the species.

Korschefsky (1932) in his catalogue employed the name *bijugus* for the species and gave its distribution as " South China " and he used the name *infernalis* for what he considered to be the sub-species occurring in India. He did not give any characters by which the two could be separated and his mention of " South China " instead of the clearly atated East Indies as the type locality for *bijugus* is obviously due to an error.

Chilocorus rubidus Hope

Chilocorus rubidus Hope, in Gray, 1831, *Zoological miscellany* (London) : 31. Mulsant, 1850, *Ann. Soc. Agric. Lyon* (2)**2** :453. Crotch, 1874, *A revision of the coleopterous family Coccinellidae* (London) : 183. Weise, 1887, *Arch Naturgesch.* **53** : 210. Blackburn (1889) 1890, *Proc. linn. Soc. N.S. Wales* (2) **4** : 1275. Lewis, 1896, *Ann. Mag. nat. Hist.* (6) **17** : 31. Korschefsky, 1932, *Coleopt. Cat., Berl.* **16**, 120, Coccinellidae II : 241. Maslovskii, 1936, *Plant Prot., Leningrad*, **8** : 157-158.

Coccinella tristis Faldermann, 1835, *Mem. Acad. St. Petersbg.* **2** : 452.

Chilocorus tristis (Fald.), Mulsant, 1850, *Ann. Soc. Agric. Lyon* (2) **2** : 452-453 Crotch, 1874, *A revision of the coleopterous family Coccinellidae* (London) : 183 (Syn.), Weise, 1887, *Arch. Naturgesch.* **53** : 210 (Syn.).

Chilocorus rubidus Hope, ab. *tristis* (Fald.), Korschefsky, 1932, *Coleopt. Cat., Berl.*, **16**, 120 Coccinellidae II : 241—242.

Body subhemispherical and moderately compressed. Head black in the front except for the distal parts of antennae and mouth-parts which are piceous or reddish-brown. Pronotum and scutellum normally black. Elytra (Text-fig. 1, *j*) deep red except on the borders along the external margins where the colour is usually black. The width of the black border varies and may be between one-fourth and one-eighth of the width of an elytron. The border in each case becomes slightly narrower towards the apex. In some apparently teneral specimens whereas the head and pronotum are piceous or black, the elytra are light brown and their external margins are either free from black pigment or have very little of it. Underside reddish except for the head, prosternum, legs and the external epipleurae which are black.

Head finely and moderately punctate and with short, thin and greyish pubescence. Antennae (Text-fig. 1, *c*) eight segemented, mouth-parts (Text-fig. 2, *f*, *b-o*) also typical of the genus. Pronotum strongly arched, with a subquadrate anterior emargination, only slightly narrowed anteriorly ; punctation rather fine and moderately close in the middle and coarse and fairly close towards the sides which have in addition, thin, short and greyish pubescence. Scutellum triangular with the base slightly shorter than the sides and with four or five minute and irregularly scattered punctures. Elytra with distinct shoulder-boils, slightly produced and raised near the anterolateral margins ; for the most parts, especially on the discal region, the punctuation is rather fine and moderately close while towards the external margins it gradually becomes coarse ; short and sparse pubescence also appears on the borders along the external margins. In the female the spermatheca (Text-fig. 1, *a*) is compact and well chitinized ; the genital plates (ninth sternite) are

tubular, the tenth tergite is subquardate apically (Text-fig. 2, *g*). Male genitalia as shown in text-figure 1, *d* (part sipho) and 1, *f* (trab, basal piece, penis and parameres).

Length 5·6—6·5 mm. *Width* 4·5—6 mm.

Biological notes.—Under the name *Chilocorus tristis* (Fald.) this species was reported to attack the larvae of the Chinese white-wax scale, *Ericerus pela* Chavannes, in Japan (*Vide* Kuwana, 1923 : 402). In the Far-eastern districts of Russia, the larvae of *C. rubidus* were reported to destroy 40—90 per cent of adult mealybug, *Lecanium corni* Boh. The beetles were stated to pass through one generation a year, and complete the life cycle in 53-58 days at 19-26°C. (Telenga and Bagunova, 1936). At about the same time, Maslovskii (1936) remarked that observations on the activity of *C. rubidus* and the fact that several other species of the genus feed on Diaspine coccids, suggested that it might be utilized against the Californian scale [*Quadraspidiotus* (*Aonidiella*) *perniciosus* (Comst.)] in the Caucasus and other parts of Russia.

In August 1940, the present writer observed a large number of these beetles on pear trees which were heavily infested with the San José Scale at Zaura, a village at about 9 miles from Srinagar, Kashmir. The beetles were seen feeding on the scale in the field and continued to do so in the cages in which some of these were subsequently placed. The beetles were observed in and arround Srinagar at later occasions also but never in such large numbers as were first observed at Zaura.

Material examined.—INDIA—Kashmir: Srinagar (5,500 ft.),-iv. 1923 (*T. B. Fletcher*). Zaura, 9 miles from Srinagar, feeding on the San José Scale on pear trees, 12. viii. 1940 (*A. P. Kapur*). Lalmandi, Srinagar, feeding on the San José Scale, 8.vii. 1941 (*A. P. Kapur*). Uttar Pradesh: Kumaon Hills, Almora (5,500 ft.), 11.x.—31.xii. 1911 (*C. Paiva*). PAKISTAN—Chitral: Izha, Lutkoh valley,—.viii. 1929 (*B. N. Chopra*); Buni, Mastunj valley,—viii. 1929 (*B. N. Chopra*). (Many examples in the Zoological Survey of India collection). MALAYA—Penang (No. further data; a single specimen in poor condition from the late East India Company's Museum collection, No. 7920/3).

Remarks.—The type locality for *Chilocorus rubidus* Hope (1831) is Nepal and that for *Coccinella tristis* Faldermann (1835) is Russia. Mulsant (1850) who transferred the latter to the genus *Chilocorus* recognized *tristis* and *rubidus* as two distinct species while Crotch (1874) synonymized the two under the name *C. tristis*. Apparently for reasons of priority Weise (1887) revived the older name *C. rubidus*, and described two new varieties under the names *fenestratus* (elytron black with a single subsutural vittaeform reddish spot) and *niger* (elytra black throughout) from Amur, U.S.S.R. Without giving reasons or pointing out the precise characters distinguishing *tristis* from *rubidus*, Korschefsky (1932) regarded the former as a variety (*ab.*) of the latter. In the opinion of the present writer this arrangement should be rejected in favour of the earlier synonymy proposed by Weise (1887).

The species is widely distributed; Korschefsky gives the following geographical distribution: "U.S.S.R.; Manchuria, Mongolia, China,

Japan, Nepal, India, Celebes and Australia ". However, its occurrence from Australia ever since it was first recorded by Mulsant (1850) from New Holland (Old name for Australia), has been rather doubtful (Crotch, 1874 ; Blackburn, 1890).

Pharoscymnus flexibilis (Mulsant)

Scymnus (*Diomus*) *flexibilis* Mulsant, 1853, *Ann. Soc. linn. Lyon* (2) **1** : 271-272.

Scymnus flexibilis Mulsant, Crotch, 1874, *A revision of the coleopterous family Coccinellidae* (*London*) : 252. Korschefsky, 1932, *Coleopt. Cat., Berl,* **16**, 120, *Coccinellidae* II : 142 ; 586.

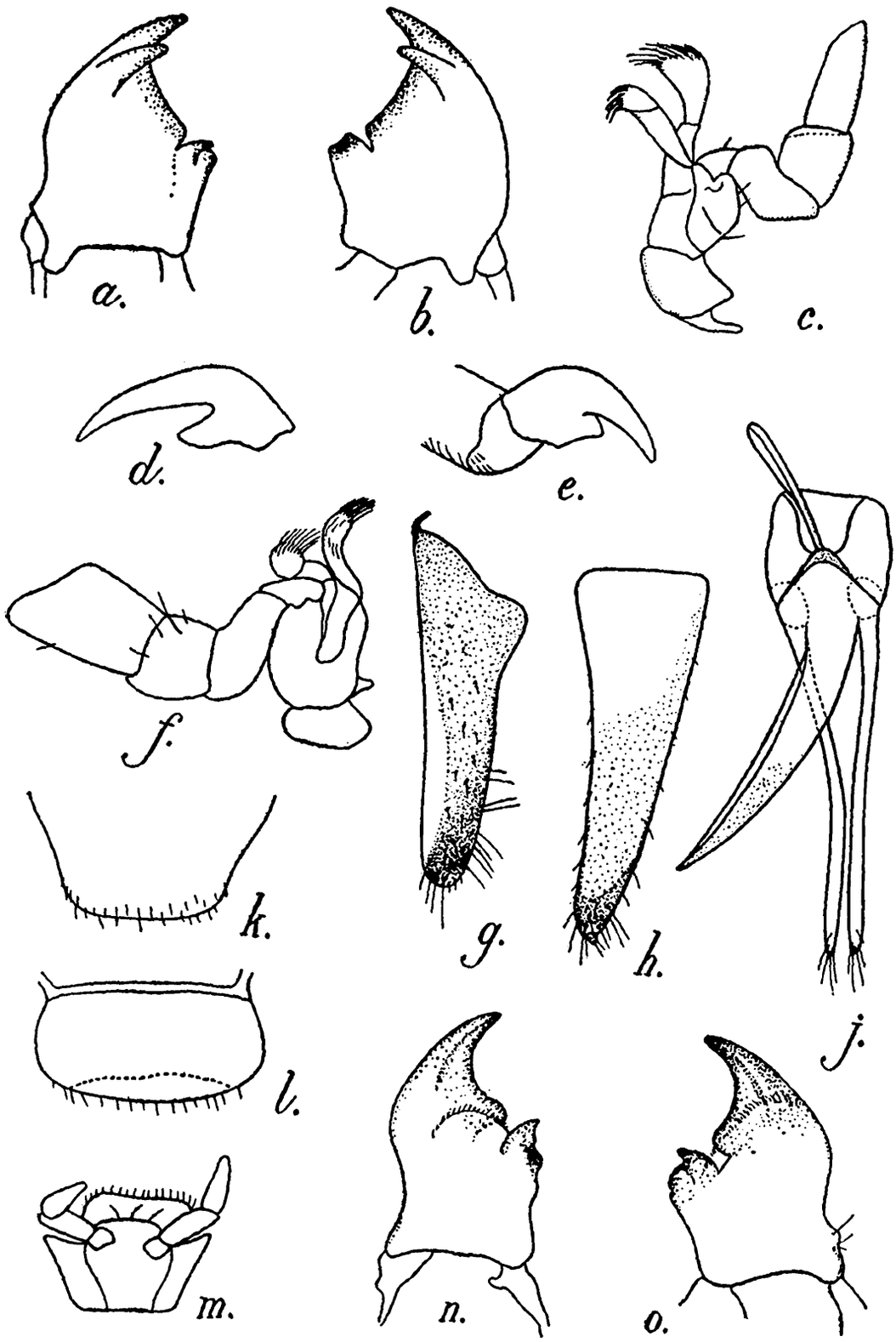
Pharus flexibilis (Mulsant), Weise, 1900, *Dtsch. ent. Z.* **1900** : 435.

Pharoscymnus flexibilis (Mulsant), Korschefsky, 1932, *Colepot. Cat., Berl.* **16**, 120. *Coccinellidae* II : 215.

Body subhemispherical (Text-fig. 3). Head testaceous to reddish testaceous except for the greyish eyes and pubescence. Pronotum and scutellum similar in colour to the head ; the latter occasionally lighter towards the lateral margins. The ground colour of elytra similar in colour to that of the pronotum ; elytral spots which are piceous to black in colour are very variable both in number and size. The maximum number of spots on an elytron may be five and the minimum two. When all the five spots are present these are arranged as follows : The first spot (numbered on the left elytron from right to left and from base to apex) is subrounded, usually small, being one-fourth to one-sixth of the width of elytron. It is situated near the base and at equal distances from the shoulder-boil and the suture. In certain examples it is altogether absent (Text-fig. 4, *a*, *b*). The second spot is situated on the suture and, together with its opposite number on the other elytron, it forms an oblong or rounded spot which may be a little larger than the first spot. It is variable in size and shape and is altogether absent in certain examples (Text-fig. 4,*a*). The third or the central spot is one of the most persistent spots which may be equal to or a little larger or smaller than the second spot (Text-fig. 4, *b*, *d*, *e*). The fourth spot lies near or on the suture in the apical one-third of the elytron and may be subrounded or semicircular in shape and is usually smaller (in an exceptional case larger) than the central spot. Though this spot is present in all the specimens examined, in certain examples it is very much faded. The fifth spot lies at the same level as the fourth spot and is equidistant from the latter and the external margin of the elytron ; when present it may be oval or rounded in shape ; in the former case its external margin runs parallel to the external margin of the elytron. On the whole the elytral spots remain small in size and usually incomplete in number. Underside generally testaceous but in examples where the elytral markings are more prominent, the thoracic and abdominal sternites may be fumous or fuscous.

Head with moderately fine and close punctures and with thin, short and depressed pubescence. Antennae ten segmented ; labrum subovate ; mandible (Text-fig. 2, *a*, *b*) with a bifid apex and a fairly strongly chitinized basal tooth ; galeae and laciniae with well defined setae, maxillary palpus with the last segment filiform rather than securiform (Text-fig. 2,*c*) ; labium subquadrate. Pronotum with the punctation and pubescence similar to that on the head. Scutellum very small,

triangular, with a few minute punctures and short grey hair. Elytar with slightly visible shoulder-boils and with punctation and pubescence similar to that of the head and pronotum except that the punctures appear to be a little shallower. Underside finely and fairly closely



TEXT-FIG. 2. *a, b.*—mandibles of *Pharoscymnus flexibilis* (Muls.). *c.*—maxilla of the same. *d.*—claw of the same (highly enlarged). *e.*—claw of *Chilocorus rubidus*. *f.*—maxilla of the same. *g.*—genital plate of the same. *h.*—genital plate of *P. flexibilis*. *j.*—male genitalia (except sipho) of the same. *k.*—tenth tergite of *C. rubidus*. *l.* & *m.*—labram and labium of the same. *n.* & *o.*—mandibles of the same.

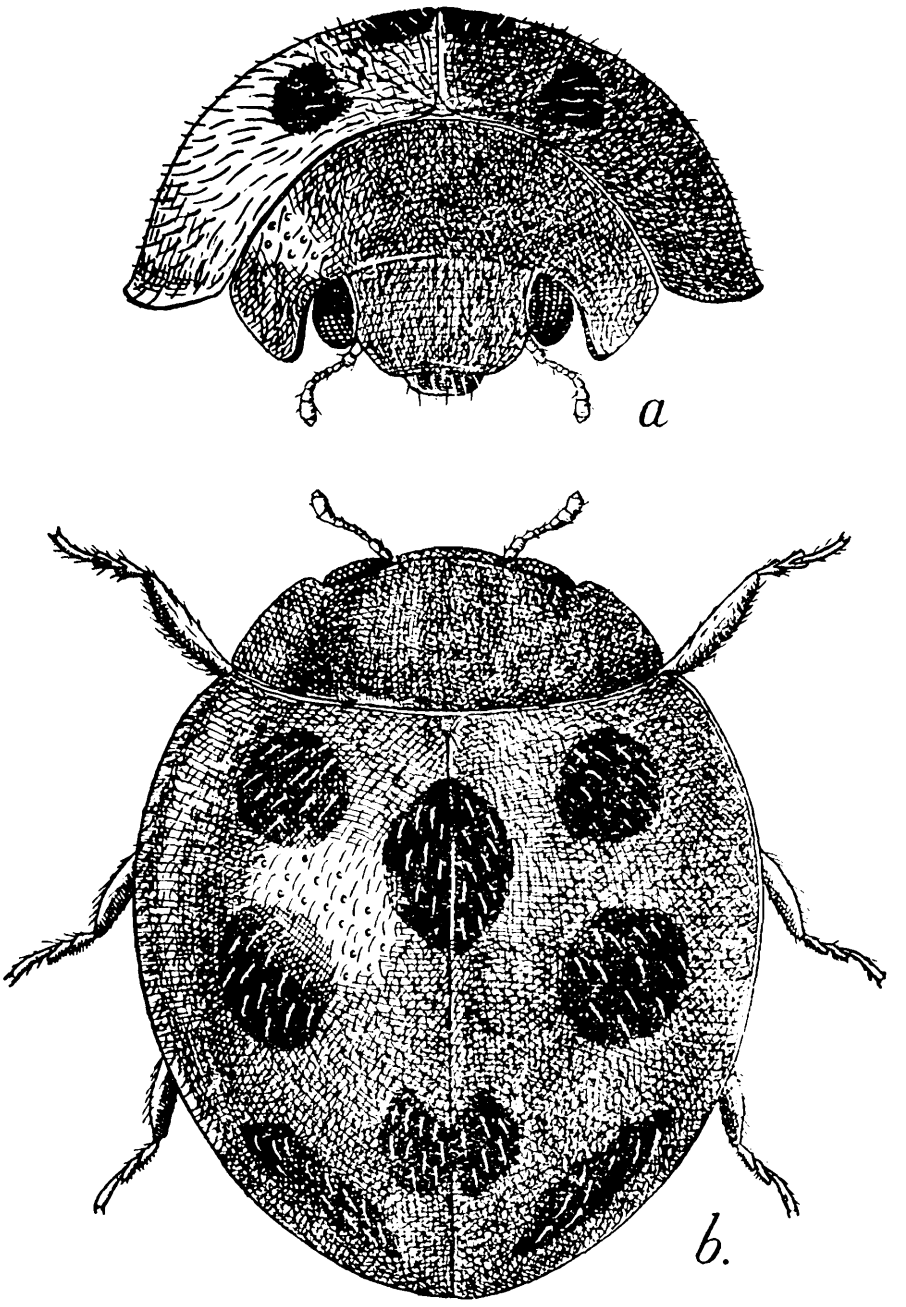
punctate except on the median parts of meso- and metasternum where the punctures are sparse; pubescence depressed, thin and short except on the distal abdominal sternites, where the hair are relatively longer. Prosternal carinae subparallel and slightly longer than the distance between the two of them; the claws are rather long (Text-fig. 2,*d*) abdominal lines terminal and incomplete; the fifth or the last visible segment entire and rounded at the apex in both sexes which remain indistinguishable on external characters except that of the size, the females being a little larger than the males. Male genitalia (Text-fig. 2, *j*) with the penis gradually narrowed towards the apex which is pointed; parameres narrow, slightly longer than the penis; sipho fairly long and narrow like the parameres. In the female the ovipositor is tubular, the genital plates (ninth sternite) elongate (Text-fig. 2, *h*) and the tenth tergite long and slightly truncate at the apex.

Length 1·82—2·0 mm.; *width* 1·48—1·65 mm.

Biological notes.—Very little is known about the feeding habits of the members of the genus *Pharoscymnus* Balachowsky (1925) recorded *P. anchorago* (Fairm.) as a predator of the armoured scale, *Parlatoria blanchardii*, in Algier and more recently Puttarudriah and Basavanna (1953) have recorded "*P. ? flexibilis* Muls." in Mysore as feeding "on an undetermined hard scale on citrus" and have further observed that it "acts as a good controlling agent." An examination of the material kindly sent by the latter authors leaves no doubt that the beetles belong to *P. flexibilis* (Mulsant).

Material examined.—INDIA and PAKISTAN-Punjab: Gandhara Reserve Forest, Choa Saidan Shah, Salt Range, 25. iv. 1931 (*H. S. Pruthi*); Lahore, 15. iv. 1935 (*A. P. Kapur*); Lahore, on peach tree attacked by coccids,—. ii. 1936, (*A. P. Kapur*). Lyallpur (no further data). Bihar: Kundri, Daltongunj Dist., 29. iv. 1951 (*A. P. Kapur*). Mysore: Bangalore, on scales on citrus leaves,— .v.1952 (*G. P. C. Basavanna*).

Remarks.—As is implied by the name of the species, there is a considerable degree of colour variation especially in the size and number of elytral spots. Mulsant stated that spots number one, two and four were indistinct and that perhaps his examples possessed incomplete markings. Mulsant made no mention of the fifth elytral spot which is no doubt more frequently absent in the material examined. The present writer had the opportunity of comparing some of his own material with the example of this species identified by Mulsant and deposited in the British Museum (N. H.) and is reasonably certain of the identity of his material. Mulsant gave the type locality as "Northern India" The fore-mentioned material which comes mostly from northern India agrees with Mulsant's description except for the presence of the additional fifth spot in certain examples. The two examples from Mysore (Text-fig. 4,*c*) also agree with Mulsant's description and do not possess the fifth spot. The material from Kashmir and other hilly tracts of northern India shows rather marked differences in colour and size and deserves to be mentioned separately.



TEXT-FIG. 3. *Pharoscymnus flexibilis* (Muls.), *a*.—front view. *b*.—dorsal view.

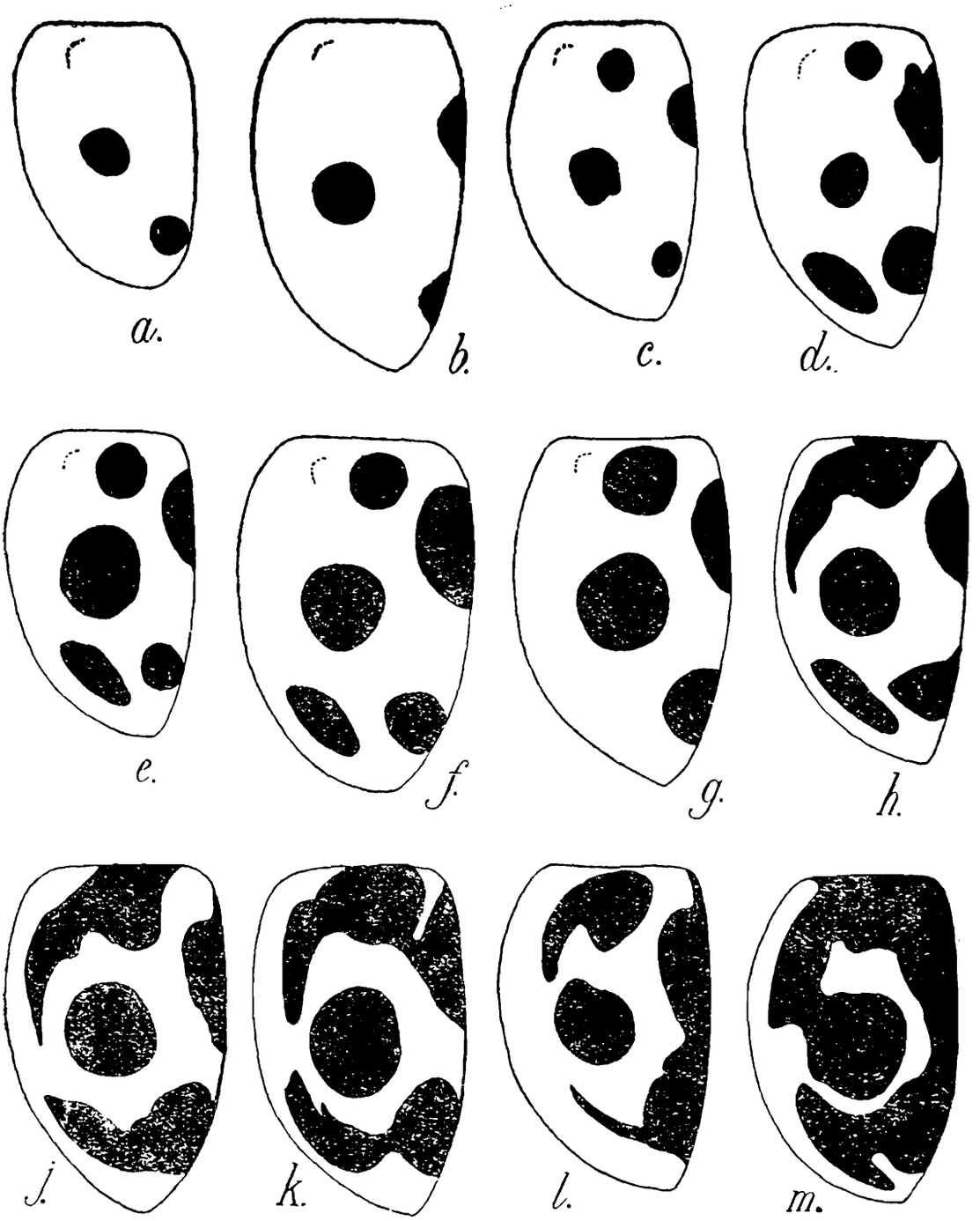
P. flexibilis kashmirensis, subsp. nov.

In structural details of genitalia (♂, ♀) and of various other parts and in punctation and pubescence, the material coming from Kashmir and neighbouring hilly tracts, tallies with the description of the species given above. In colouration and size, however, the bulk of this material is different, being more heavily pigmented and larger in size than the material from the plains of northern and other parts of India. Dealing with the material from Kashmir first, the colouration may be described as follows :

Head fuscous in front and piceous at the vertex or entirely piceous. Pronotum also fuscous to piceous and usually a little lighter towards the lateral marg ns. Elytra (Text-fig. 4, *g-m*) with four or five spots on each elytron ; when with four spots, it is the spot No. 5 that is absent (*g*) but the size of the spots remains large, being equal to one-third to two-fifths of the maximum width of the elytron ; very often when all the

five spots are present, these are much enlarged in size and show a tendency to meet the other spots (*h*). In the examples where the spots have become confluent, their arrangement may be as follows (+indicates the confluence of spots): 1+2, 3, 4+5 (*k*); 1, 2+4, 3 (*l*); 1, 2, 3, 4+5 (*j*); 3+2+1+4+5 (*m*). Underside also variable in colour at the thoracic and abdominal sternites and may be fuscous or piceous; the legs and epipleurae (thoracic and elytral), however, always remain testaceous or reddish testaceous.

Measurements of six specimens chosen at random from (A) the material from Kashmir and similarly from (B) the material from the



TEXT-FIG. 4. Elytral patterns of *Pharoscymnus flexibilis* from *a.*—Lyallpur; *b.* & *d.*—Lahore; *c.*—Bangalore. The same of *P. flexibilis kashmirensis* from *e.*—Almora (5,500 ft.); *f.*—Cherat (4,000 ft.); *g*—*m.*—Kashmir, Srinagar (5,500 ft.).

plains of Punjab, Bihar and Mysore (described in preceeding account of the species) are given below. Besides the geographical factors, the abundance or scarcity of food may also be quite important in determining the size of the beetles. In the Kashmir valley their food is plentiful.

A. (1) Length 2·173 mm., width 1·826 mm. (2) Length 2·173 mm., width 1·826 mm. (3) Length 2·130 mm., width 1·782 mm. (4) Length 2·086 mm., width 1·739 mm. (5) Length 2·130 mm., width 1·782 mm. (6) Length 2·086 mm., width 1·739 mm. *Average length* 2·130 mm. ; *average width* 1·782 mm.

B. (1) Length 1·913 mm., width 1·565 mm. (2) Length 1·826 mm. width 1·482 mm. (3) Length 1·913 mm., width 1·565 mm. (4) Length 1·913 mm., width 1·565 mm. (5) Length 2·000 mm., width 1·652 mm. (6) Length 1·913 mm., width 1·565 mm. *Average length* 1·913 mm. ; *average width* 1·565 mm.

The material from other neighbouring hilly tracts is represented by only one specimen each from Cherat (4,000 ft., in N. W F. Province) and W Almora (5,500 ft., Kumaon Hills, Uttar Pradesh). In the former specimen the head and pronotum are fuscous and the thoracic and abdominal sternites as piceous as in the case of certain examples from Kashmir ; the elytral spots (Text-fig. 4,*f*) are five in number and are relatively large in size but these do not show the same tendency to coalesce with the neighbouring spots. The specimen is also comparable in size to the material from Kashmir and may well be regarded as belonging to the same subspecies until more information is brought to light. The second example which is from W Almora, has the following colouration. Head piceous ; pronotum piceous except for a small testaceous area near each of the lateral margins ; elytral spots (Text-fig. 4,*e*) five, all deeply piceous and relatively large ; underside with piceous thoracic and abdominal sterna ; length 2·00 mm., width 1·56 mm. This specimen may also be provisionally placed along with the forementioned material for similar reasons.

Holotype.—INDIA—Kashmir : Srinagar (5,500 ft.) feeding on the San José Scale, 14. viii. 1940 (*A. P. Kapur*) ; a female (elytral pattern as in Text-fig. 4,*l*) in the Zoological Survey of India, Indian Museum, (Regd. No. 9623/H4).

Paratypes.—INDIA—Kashmir : Srinagar (5,500 ft.) feeding on the San José, Scale, 4.x.1939 ; 14.viii.1940 (*A. P. Kapur*). Six examples

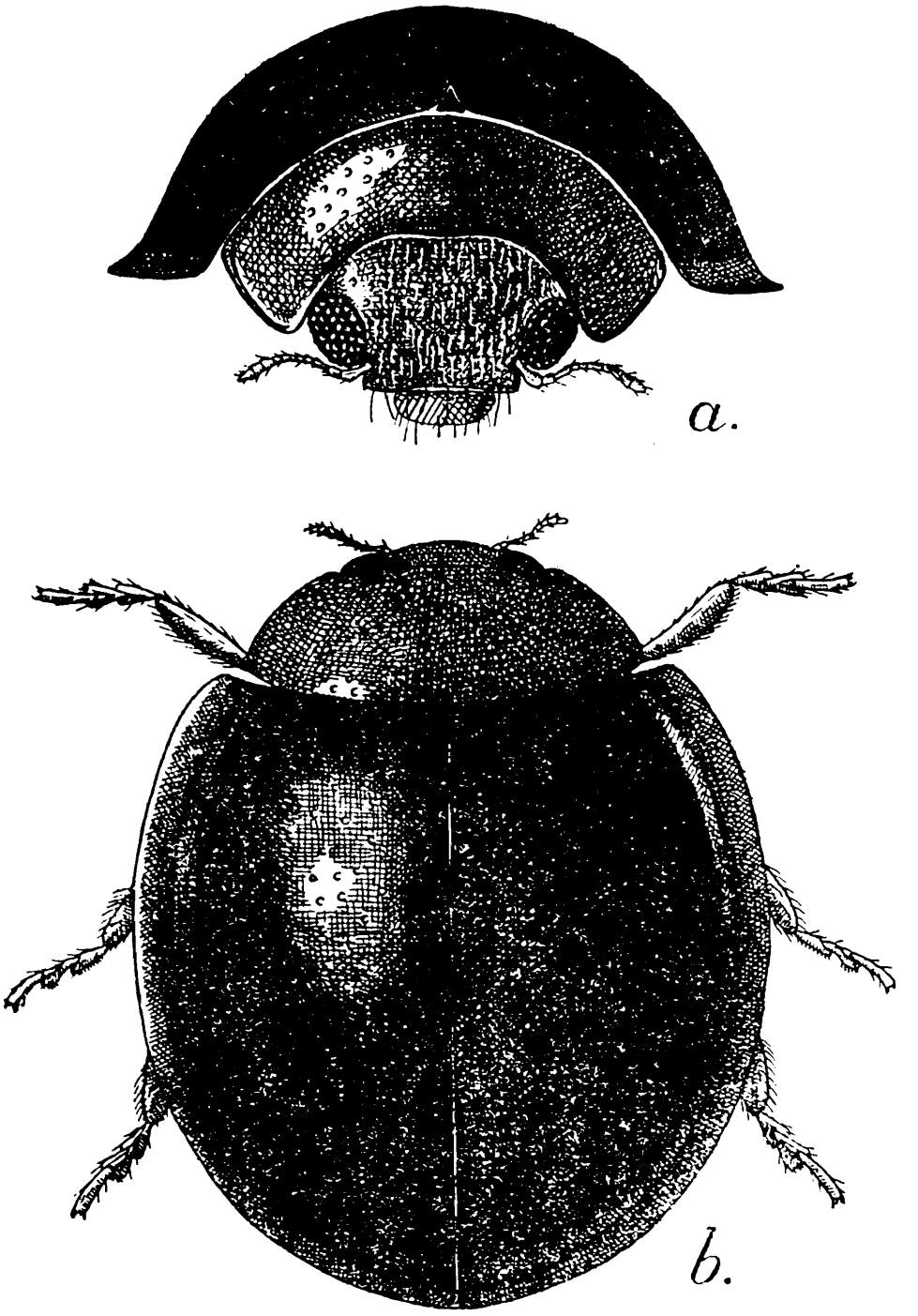
representing both sexes; some dissected for genitalia study and other parts mounted on slides, etc.; all in the Zoological Survey of India (Regd. Nos. 9624—9629/H4). One example each from Cherat and W. Almora bear the following data: (1) N. W. F. Province: Cherat (4,000 ft.), on *Pinus longifolia* infected with Coccids,—. v. 1916 (*T. B. Fletcher*). (2) Uttar Pradesh: Kumaon Hills, W. Almora (5,500 ft.) (*H. G. Champion*) (Example on loan for study from the British Museum (N. H.). A number of other examples from Kashmir also dissected and mounted.

Remarks.—The beetles are important natural enemies of the San José Scale in Kashmir. Their larvae which have a dull colour like the adults are also voracious feeders and destroy a large number of the scales. The larvae are well clothed with moderately long setae, and pupate in the open or under bark on the trees. The pupae are also of dull colour and are not protected by the larval skin which remains cast at the proximal end of the pupa. Hibernation takes place in the adult stage. There is very little incidence of parasite attack and the beetles are more common in the valley than either of the preceeding two species.

Sticholotis marginalis, sp. nov.

Body subrounded, a little longer than wide, convex. Head castaneous except for the black eyes and the light castaneous mouth-parts Pronotum uniformly of the same colour as the head. Scutellum black or piceous, like the colour of the elytral disc. Elytra black or piceous except for a castaneous, narrow border (as wide as about one-eighth of the width of the elytron) along the external margin. Underside with the meso and metasternum and the proximal abdominal sternites black or piceous and with the prosternum, epipleurae and legs-brown or castaneous but usually lighter than the colour of pronotum.

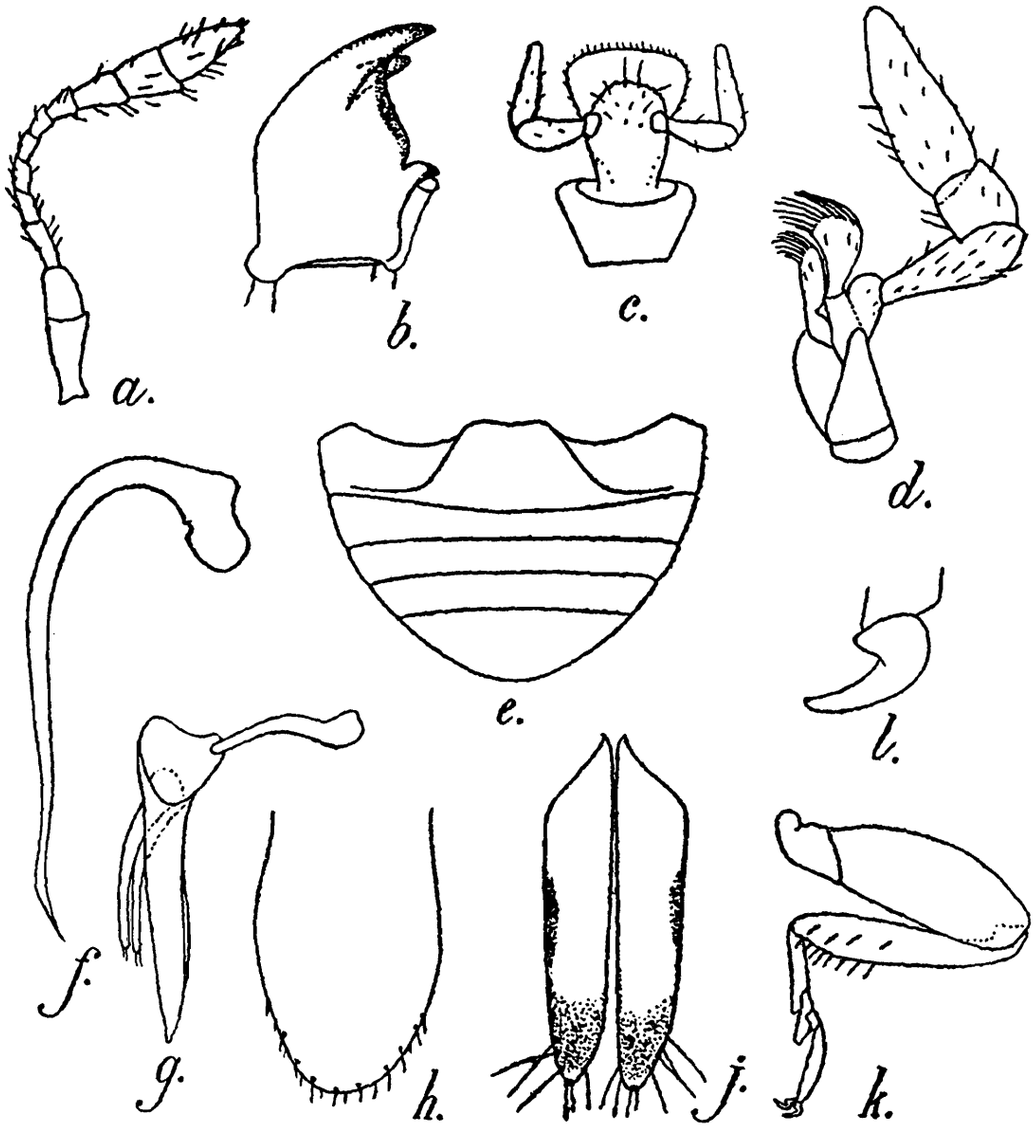
Head slightly convex in front, with fine, well impressed and fairly close punctation and thin, short, sparse and rather golden pubescence. Eyes coarsely granulated. Antennae (Text-fig. 6,*a*) eleven segmented, with the terminal segment subconical; labrum ovate; mandible bifid at the apex, with strongly chitinized inner margin and basal tooth (Text-fig. 6,*b*); maxillary palpi fairly long with the last segment conical rather than securiform (Text-fig. 6,*d*); mentum subquadrate (Text-fig. 6,*c*).



TEXT-FIG. 5. *Sticholotis marginalis*, sp. nov. *a*.—front view ; *b*.—dorsal view.

Pronotum fairly convex, widely emarginate in front, with the punctation similar to that on the front of the head and with a trace of very short pubescence present only near the sides which together with the base are narrowly margined. Scutellum very small, triangular and with a few fine punctures. Elytra with rather indistinct shoulder-boils ; slightly raised on the external extremity which is narrowly margined ; punctation mixed, coarser punctures moderately impressed, well-spaced and arranged in rather indistinct rows which are usually not more than five on an elytron ; in between the rows the punctation is fine, rather shallow and moderately close. Underside with the prosternum having a pair of carinae which are not parallel but slightly convergent towards the

apex ; the space between the carina has a few fine punctures. Mesosternum coarsely and sparsely punctate ; metasternum with relatively fine and rather close punctures ; legs sparsely and finely punctate with the claws pointed at apex and each having a small basal tooths (Text-fig. 6, *k*, *l*). Abdominal lines terminal and incomplete ; the fifth or the last abdominal sternite rounded along the external margin in both sexes (Text-fig. 6,*e*). Male genitalia, and the elongate genital plates (ninth sternite) and the apically rounded tenth tergite of the female, as shown in text-figure 6, *f-j*.



TEXT-FIG. 6. *Sticholotis marginalis*, sp. nov. *a.*—antenna ; *b.*—mandible ; *c.*—labium ; *d.*—maxilla ; *e.*—abdominal sternites (♂) ; *f.*—sipho ; *g.*—male genitalia (except sipho) ; *h.*—tenth tergite of female ; *j.*—genital plates (ninth sternite of female) ; *k.*—leg ; *l.*—claw (highly magnified).

Length.- 1·9-2·0 mm. ; *width* 1·5-1·6 mm.

Holotype.—INDIA—Kashmir : Srinagar, feeding on the San José Scale, 16.vi.1943 (*A. P. Kapur*)—A male in the Zoological Survey of India, Indian Museum (Regd. No. 9631/H4). Genitalia and abdomen mounted on a slide.

Allotype and 2 Paratypes.—All females, with the same data as the holotype, in the Indian Museum—Zoological Survey of India (Regd. No. 9632—9634/H4). Text-fig. 5 of the beetle is of a paratype. Female genitalia of allotype mounted between two coverslips and attached to the specimen the same of a paratype on a slide.

Remarks.—The species can be easily distinguished from other Indian species of the genus by its shape of the body, the colouration of elytra and the character of the punctation. The genus is widely spread in the Oriental and Australian Regions but its species are very inadequately known.

The beetles of this species feed on the San José Scale in Srinagar and several other places in the Valley. Occasionally nymphs of the woolly aphis (*Eriosoma lanigerum* Hausm.) are also attacked.

SUMMARY.

The San José Scale is a serious pest of fruit trees in Kashmir and several other parts of the world. A study of its natural enemies is, therefore, of more than local interest. A list is given of all the recorded Coccinellid predators on the San José Scale in different parts of the world. Although four species of these beetles were observed to feed on the Scale in Kashmir, only one of these, namely *Chilocorus bijugus* sub-sp. *infernalis* Muls., seems to have been recorded in literature. This species together with *C. rubidus* Hope, has been redescribed in this paper and notes on their taxonomy and biology added. *Pharoscymnus flexibilis* (Mulsant) has also been dealt with similarly and a new subspecies which feeds on the Scale in Kashmir has been named as *P. flexibilis kashmirensis*. The fourth species which also appears to be new, has been described and named as *Sticholotis marginalis*.

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