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Tanaostigmodes cajaninae LaSalle sp. n. (Hymenoptera: Tanaostigmatidae), a potential pest of pigeon pea in India*

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Abstract

Tanaostigmodes cajaninae LaSalle sp. n., the larvae of which feed in pods of pigeon pea (*Cajanus cajan*), is described. This insect, which also feeds on the weeds *Atylosia* spp. and *Rhynchosia* spp., has reached pest status on ICRISAT's research farm in Andhra Pradesh, India, where more than half of the pods on the late-maturing pigeon pea crops may be infested. However, surveys of the crops in farmers' fields in India showed that, although this insect is widespread, it is not yet a serious pest. The abnormal populations of this insect on the ICRISAT research farm appear to be associated with an abundance of its wild hosts, the availability of pigeon pea pods for many months in each year and the use of endosulfan, which does not control the pest but reduces its parasites. The potential for *T. cajaninae* to become a major pest in farmers' fields is discussed, and control measures are suggested.

In 1975, soon after the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) embarked upon an intensive study of the insect pests of pigeon pea, *Cajanus cajan*, a hitherto unrecorded insect pest of this crop was noticed at the ICRISAT research farm (1400 ha) at Patancheru (17°N, 78°E) in India. Specimens were sent to the Commonwealth Institute of Entomology where they were identified by Dr B. R. Subba Rao, as *Tanaostigmodes* sp. (Chalcidoidea: Tanaostigmatidae). Later, LaSalle asked for specimens, and his description of this insect is included in this paper. A preliminary report on this insect was published by Lateef (1977), but as *Taraostigmodes* sp., a typographical error that was corrected by Davies & Lateef (1978). Subsequently, this insect has been studied in some detail at ICRISAT, and the results are summarized in this paper.

Female. Length 2·0–2·65 mm. Head, antennae, thorax and coxae black. Middle and hind legs yellow to honey yellow; foreleg yellow ventrally, femur brown to black dorsally, tibia slightly infuscated to brown dorsally. Gaster yellow, with dorsal infuscated area

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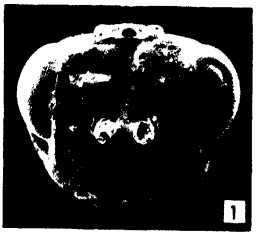
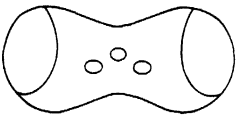
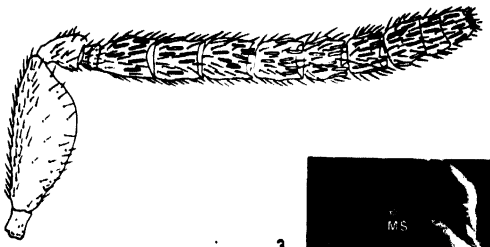
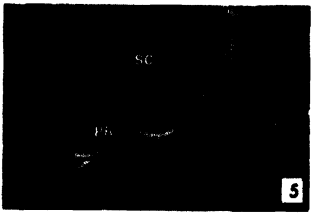
laterally and posteriorly on terga 4–9; this infuscated area increasing in size and darkness posteriorly.

Head (Fig. 1) 1·20–1·28 times wider than high; scrobal impression shallow; small carina present ventral to and slightly lateral to torulus. Ocelli in very obtuse triangle, situated on









Figs. 1–5.—*Tanaostigmodes cajaninae* sp. n. ♀; 1, head, frontal view; 2, head, dorsal view, showing position of ocelli; 3, antenna; 4, thorax, dorsal view; 5, propodeum. (ax = axilla, ms = mesoscutum, pr = propodeum, sc = scutellum.)

slight prominence on vertex; lateral ocellus 1·88–2·13 times as far from eye margin as from median ocellus (Fig. 2). Antenna inserted at 0·35–0·40 times the height of head, level with ventral margin of eye. Antenna (Fig. 3) with two anelli, six funicular segments and a three-segmented club. Scape ventrally produced, flattened, 2·10–2·30 times longer than wide; first anellus slightly narrower and about half the length of the second anellus; funicular segments 1–5 longer than wide, decreasing in length distally, the ultimate funicular segment subequal in length and width; club slightly truncate apically, 1·95–2·36 times longer than wide, subequal in width to the funicle.

Pronotum vertical, not or only slightly visible in dorsal view. Parapsidal sutures sinuate, meeting slightly before posterior margin of mesoscutum. Axilla (Fig. 4) large, triangular, with distinct lateral carina. Scutellum (Fig. 4) longer than wide, pointed anteriorly, narrowly rounded posteriorly, with a few scattered setae along lateral margins. Propodeum (Fig. 5) polished between spiracles except for a few median, longitudinal plicae. Prepectus large, swollen, broadly joined to anterior margin of large, convex mesopleuron (Fig. 6).

Wings (Fig. 7) hyaline, veins light brown. Forewing with costal cell 2·07–2·20 times longer than marginal vein; marginal vein 1·28–1·57 times longer than postmarginal vein, 1·25–1·41 times longer than stigmal vein; stigmal vein 1·0–1·14 times longer than postmarginal vein.

Gaster with dark setae posteriorly on all but first and last terga, and a small cluster of dark setae just anterior to pygostyle (Fig. 8).

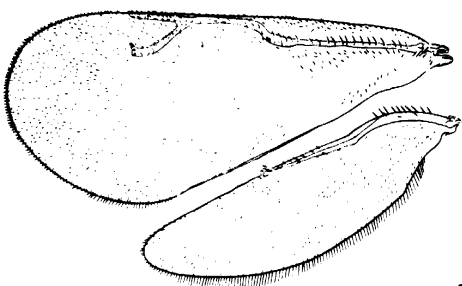
Male. Length 1·69–2·27 mm. Differs from female in sexual characters and the following: antenna (Fig. 9) with scape not as ventrally produced and flattened as in female, 2·75–3·05 times longer than wide. All funicular segments longer than wide and bearing numerous setae which are slightly longer than ½ the width of the funicle. Funicular segments 1–3 slightly produced dorsally. Dorsum of gaster predominantly brown.

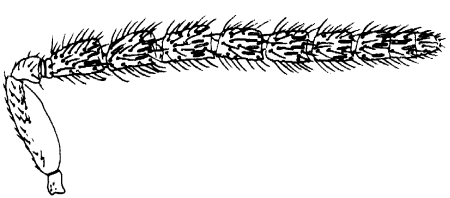
T. cajaninae is the first tanaostigmatid described from India, but several similar species are known from Australia. Morphologically it is most closely related to *T. globosus globosus* Girault (1915:44) and *T. globosus novus* Girault (1915:44), which have the scape ventrally produced and flattened and a black head, mostly black thorax, and yellow legs and gaster. However, *T. cajaninae* can be easily separated from other species by the following combination of characters: head and thorax black, legs and gaster generally yellow; scape ventrally produced and flattened, less than 2·5 times as long as wide; antenna entirely black (pedicel and anelli yellow or white in *T. g. globosus* and *T. g. novus*); thorax entirely black (thorax at least partially yellow in closely related Australian species); lateral ocellus about twice the distance from eye margin as from median ocellus (Fig. 2) (*T. g. globosus* and *T. g. novus* have the lateral ocellus about equidistant from the eye margin and the median ocellus); presence of a cluster of short, dark setae just anterior of pygostyle (Fig. 8) (this cluster is absent in close relatives from Australia).

Material examined. Holotype ♀, INDIA: Patancheru, Andhra Pradesh, 30.xi.1982, (*S. S. Lateef*) from pods of *Cajanus cajan*. Paratypes, INDIA: 41 ♀, 14 ♂, same data as holotype.

All types mounted on card points. Holotype female, 12 female and two male paratypes in the British Museum (Natural History), London, England. Three female and one male paratypes have been placed in each of the following collections: Zoological Survey of India, Indian Museum, Calcutta, India; United States National Museum of Natural History, Washington, D.C., USA; Aligarh Muslim University, Aligarh, Uttar Pradesh, India; Queensland Museum, Brisbane, Queensland, Australia; University of California, Riverside, California, USA; Center for Parasitic Hymenoptera, Gainesville, Florida, USA; Canadian National Collection, Ottawa, Ontario, Canada; Plant Protection Research Institute, Pretoria, South Africa; Zoological Institute, Leningrad, USSR. Two female and two male paratypes, each with one pair wings and both antennae removed and mounted on a slide in balsam, in the collection of the author.

The name *cajaninae* indicates that the host-plants are *Cajanus cajan* and other related species.





Figs. 6–8.—*Tanaostigmodes cajaninae* sp. n. ♀: 6, thorax, lateral view; 7, wings; 8, apex of abdomen, showing cluster of setae anterior to pygostyle. 9.—*T. cajaninae* sp. n. ♂, antenna. (mp = mesopleuron, pp = prepectus.)

Bionomics and symptoms

The eggs, which are flattened, oval and translucent, measuring 0·8 × 0·4 mm, are laid singly on the flower thalamus and very young pods. The white, apodous larva penetrates the pod where it feeds upon a seed and the inner pod wall, reaching a length of 2·5 mm. Metamorphosis takes place within the pod locule, and the adult emerges through a small circular hole in the pod wall. Under laboratory conditions (*ca.*25°C), the larval period ranged from eight to ten days, the pupal period from five to seven days and adults survived for up to seven days (males) and nine days (females).

Many infested pods fail to develop (Fig. 10) and are either shed or retained upon the plant. Normal adult insects emerge from these undeveloped pods. In other pods, the uninfested locules develop normally and produce good seeds. The basal locule is most commonly infested, but other locules are also occasionally infested. The infested locules remain undeveloped and constricted, so giving the typical damage symptoms illustrated in Fig. 10.

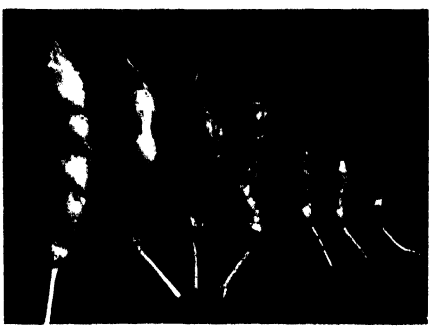


Fig. 10.—Pigeon pea pods damaged by *Tanaostigmodes cajaninae*, with an undamaged pod on the left.

Host range

Surveys of the wild relatives of pigeon pea on ICRISAT's farm from 1977 to 1983 revealed that *T. cajaninae* was very common on some of these. The percentages of pods collected from *Atylosia* spp. that were damaged by this insect were as follows (with the total numbers of pods that were sampled in brackets):

A. scarabaeoides	39·7% (38067)
A. albicans	26·3% (9249)
A. lineata	8·5% (200)
A. cajanifolia	2·4% (7892)
A. platycarpa	0·8% (3389)
A. sericea	0·5% (23546)

Of these host-plants, *A. scarabaeoides* is a common weed on and around the ICRISAT research farm and in many other areas of India. The other species are less common and have relatively restricted habitats, but are grown in germplasm nurseries at ICRISAT.

Typical symptoms of damage by this insect were recorded also in pods collected from *Rhynchosia bracteata*, *R. rothii*, *R. cana* and *R. densiflora*, these being common plants in many areas of India.

Pest status in pigeon pea on ICRISAT research farm

A large number of insect species have been recorded as damaging pigeon pea (Davies & Lateef, 1975). Lepidopterous larvae, particularly of *Heliothis* spp., are the most damaging pests, both in India and in the many other countries in which this crop is of importance. In India, the dominant pests are *H. armigera* (Hübner) and the podfly, *Melanagromyza obtusa* (Malloch). Most pest-caused loss occurs in the pods and loss assessment is commonly based upon the percentages of pods or seeds that are recorded as damaged. At ICRISAT, random samples of pods (400–600) are taken from each plot just before harvest and each pod is examined, both externally and internally, for pest damage. The damage caused by each of the major pests is easily distinguishable so the number of pods damaged by each pest, including *T. cajaninae*, is recorded.

Most pigeon pea in India is sown soon after the monsoon rains begin and harvested either after the rains cease or, in northern India, after the winter. At ICRISAT, it is normally sown in June or July and the time of harvest ranges from October to April, according to the genotype. In each year, pods have been sampled from the individual plots of very many trials, most of which are concerned with the search for host-plant resistance to the major pests. The summaries of the data collected from several thousand samples in each year are recorded in the Annual Pulse Entomology Departmental Progress Reports, which are available on request from ICRISAT. The percentages of pods damaged by *T. cajaninae* have ranged from less than 1% to more than 80% in each year. There is an obvious and consistent effect of genotype duration-harvest timing on the incidence of damage, the later maturing crops having a much greater proportion of their pods damaged than the earlier maturing crops. Typical examples of this are shown in Table I.

TABLE I. *Percentages of pods damaged by* Tanaostigmodes cajaninae *in samples taken from trials of short, medium and long duration genotypes of pigeon pea at ICRISAT*

Genotype duration	Month harvested	1981–82		1982–83	
		n	Mean % (ranges)	*n*	Mean % (ranges)
Short	Nov.–Dec.	9	16·3 (6·2–32·6 ± 4·46)	12	10·3 (0·4–19·3 ± 2·82)
Medium	Jan.–Feb.	25	22·9 (1·9–83·2 ± 3·88)	18	25·9 (5·4–62·9 ± 7·01)
Long	March	24	49·7 (19·0–86·7 ± 5·23)	15	32·6 (11·3–57·2 ± 4·48)

n = number of genotypes tested

The data in Table I are from trials where the crop was protected from damage by *H. armigera* with sprays of endosulfan. There has been a general, but inconsistent, tendency towards a greater incidence of damage by *T. cajaninae* in such trials compared with pesticide-free trials. An example of this is shown in Table II where data from pesticide-free and endosulfan treatment trials of 16 genotypes are summarized. Here, the reduction in damage caused by *H. armigera* in the endosulfan treatment trial was offset by a large increase in *T. cajaninae* infestation. Use of endosulfan resulted in a small increase in yield as *H. armigera* also destroyed many of the flowers, leading to a reduction in the number of pods in the pesticide-free trial. Well-grown pigeon pea can normally be expected to yield well over 2000 kg/ha when all the pests are adequately controlled.

TABLE II. *Percentages of pods damaged by* Tanaostigmodes cajaninae *and by the total pest complex, and the seed yields from 16 pigeon pea genotypes in pesticide-free (5 replicate, balanced lattice square design) and endosulfan treatment (3 replicate, randomized block design) trials at ICRISAT in 1979–80*

	Pesticide-free trial			Endosulfan treatment trial		
	Pods damaged (%) by:		Yield (kg/ha)	Pods damaged (%) by:		Yield (kg/ha)
Genotype	*T. cajaninae*	Pest complex		*T. cajaninae*	Pest complex	
8102 E1	4·0	52·8	721	34·8	58·2	1108
4745-9 E1	3·9	58·6	638	29·2	59·7	864
PPE 36-1	12·6	58·5	770	58·0	77·4	569
PPE 37-3	6·1	53·5	666	26·8	54·4	895
4185 E1	1·5	49·6	649	33·4	60·4	869
7176-5 E1	2·1	56·8	538	24·1	58·0	792
7194-1 S4	3·0	44·8	608	38·1	61·4	880
4745-2 E8	0·8	49·4	779	17·8	50·3	933
8614	8·4	57·7	732	50·9	70·9	1029
8619	6·5	53·1	801	51·1	69·9	858
7537	1·7	50·5	858	28·0	52·5	1487
PPE 38-1	6·2	61·1	716	50·2	70·0	835
7716-18 E2	3·1	52·3	700	28·3	54·6	1048
7041 E1	1·6	49·5	822	21·7	51·3	1244
7197	2·4	56·6	853	38·1	63·8	1132
NP(WR)15	5·9	47·5	876	53·3	69·9	1059
s.e.	1·25	2·14	54·5	5·01	3·47	111·4
Trial means	4·4	53·3	733	36·5	61·4	975

It is difficult to estimate the actual yield loss caused by *T. cajaninae* as it is only one component of the pest complex. The pigeon pea plant produces many more flowers and pods than can be held to fruition, so the loss of many flowers or small pods by insect damage can be compensated for by continued production and retention of later flowers and pods. However, there is no doubt that *T. cajaninae* is now a pest which greatly reduces the yields of the later maturing pigeon pea crops on ICRISAT's research farm.

Incidence in farmers' fields

From 1975 to 1981, the pigeon pea crops in farmers' fields in the major production areas of India were sampled for pest damage just before harvest. Samples of pods were collected at random from the maturing plants and the percentages of damage caused by pests were determined by external and internal examination. The data from these surveys are summarized in Table III. It can be seen that, although *T. cajaninae* was widespread, it was of little or no importance as a pest in farmers' fields. In limited surveys of pigeon pea crops in the Americas, Africa, Australia and across Asia, outside the Indian subcontinent, the typical damage caused by this pest has not been noticed.

TABLE III. *The percentages of pigeon pea pods, sampled from farmers' fields just before harvest, that were damaged by pests in India in 1975–81*

Pests	Northern India (above 23°N)	Central India (20–23°N)	Southern India (below 20°N)
Lepidopterous borers	15·2	24·3	38·6
Melanagromyza obtusa	20·1	22·3	11·7
Callosobruchus spp.	0·2	2·2	6·3
Tanaostigmodes cajaninae	0·4	1·6	2·4
No. of fields sampled	407	446	444

Parasitism

Observations on the ICRISAT research farm indicated that *T. cajaninae* larvae collected from the field tend to have substantial levels of parasitism. For example, from 600 infested pods collected from a pesticide-free block of pigeon pea in November 1982, parasites emerged from 318 (53%). However, from a similar collection of pods from pesticide-free plots within an endosulfan-treated block parasites emerged from only 91 pods (15%). The reduction in the natural enemies may explain the apparent increase in the incidence of this pest in pesticide-treated fields.

A sample of these parasites was examined by Dr E. Grissel of the U.S. National Museum. He identified many specimens of a torymid, *Senegalella* sp., probably a new species. This appears to be the first record of *Senegalella* from India. The sample also contained one specimen of *Eurytoma* sp. and two species of eupelmids, which await more precise identification.

Data collected over several years clearly show that the incidence of *T. cajaninae* on the ICRISAT farm is much greater than in farmers' fields. There appear to be three factors that contribute to this abnormality.

(1) Substantial populations of the wild host-plants, particularly *A. scarabaeoides*, flourish throughout the year on ICRISAT's farm, thus providing a continuous host supply for this insect. In most farmers' fields, grazing by goats and other domestic animals greatly reduces the availability of such hosts.

(2) Many genotypes, with a wide range of duration are grown on ICRISAT's farm. This ensures that pigeon pea pods are available from September to April in each year. In most areas of India, the farmers grow genotypes with a narrow range of durations so pigeon pea pods are generally available for less than three months in any area. Thus, on the ICRISAT farm, more generations of *T. cajaninae* can build up on pigeon pea than in farmers' fields.

(3) Surveys of pesticide use on pigeon pea in farmers' fields have indicated that less than 10% of the crop in India is treated (Bhatnagar *et al.*, 1982). On ICRISAT's farm, most of the pigeon pea is sprayed with endosulfan for *H. armigera* control. This pesticide is not effective in controlling *T. cajaninae*, but although it is generally promoted as being relatively safe to beneficial insects, it has apparently led to a reduction in the numbers of the parasites of *T. cajaninae*.

Although *T. cajaninae* is of no importance in farmers' fields at present, it might become an important pest if changes in agronomic practices lead to a more favourable environment for its multiplication. There are indications that this may be happening already in some areas, for pigeon pea is being sown after the monsoon rain as well as at the traditional time, so providing pigeon pea pods as hosts for this insect for an extended period in each year. Also, the use of insecticides appears to be increasing on this crop. It would therefore seem prudent to monitor this insect and to consider means of control. The limitation of the agronomic changes or the use of a pesticide that would control *T. cajaninae* are the obvious remedies. In addition, there appear to be substantial differences in the susceptibility of some pigeon pea genotypes to this insect (Table II), so host-plant resistance may provide a convenient and economic means of control.

We wish to thank the staff of the Pulse Entomology sub-program of ICRISAT, particularly Messrs V. R. Bhagwat and K. V. Prasada Rao for their hard work in collecting the data that form the basis for much of this paper. We also acknowledge the assistance of Sally T. McAlpin who provided the drawings.

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