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GALLS OF PEMPHIGINAE (HOMOPTERA : APHIDOIDEA) IN THE INDIAN REGION WITH DESCRIPTION OF A NEW SPECIES

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ABSTRACT

The present paper provides an account of gall aphids and aphid galls of the subfamily Pemphiginae in the Indian region. Moreover, host association, gall record and biological knowledge of such species in the region have also been included. A new gall forming species, *Kaltenbachiella carpinicola* infesting *Carpinus* sp, is described in this paper. A total of 27 species including 8 newly recorded one under this subfamily are known to produce galls in the area.

Introduction

Aphid galls are anatomically and histologically complex, formed mostly on the primary host-plants, in the course of heteroecious life cycle and association with true galls is regarded to be of primitive origin. Aphid galls may be covering galls, pouch galls, krebs galls and leaf fold or roll galls (Mani 1964). Amongst the members of Aphididae, species belonging to Pemphiginae are well known as gall makers ; of these, many species migrate to secondary hosts to complete the cycle (Table 1) while some may either become autoecious on primary host or may become restricted to a paracycle on secondary host and the situation in Indian region cleary indicates prevalence of the second condition ; out of more than 60 Pemphigids under 3 tribes known from Indian region, about 27 species are known to form galls. Many of these Pemphigid galls from Indian region have been described by Buckton (1896, 1897), Keiffer (1908), Das (1918), Gulamullah (1941), Mani (1973) and Habib and Ghani (1970) ; galls for eight species are reported here for the first time. So far, no key for identification of aphid species by their galls in the region is available. Several collection trips to Northwest and to Northeast India and Sikkim by the authors have enabled to prepare a key to the aphid species basing on the plant galls. The collection data for many of these species would indicate period of occurrence, while for the others, information have been incorporated from published literature.

TABLE—1

Host Association of Pemphiginae

	Primary Host	Secondary Host
I.	Tribe Pemphigini	[mostly known from primary host in the region]
	Sub Tribe Pemphigina	
	Populus (Galls)	Dicot Plants (Roots)
	Sub Tribe Prociphilina	
	Dicot Plants (Galls)	Conifers (Roots)
II.	Tribe Eriosomatini	[mostly known from secondary hosts in the region]
	Ulmus (Galls)	Rosaceae
	Carpinus (Galls)	Graminae
III.	Tribe Fordini	[mostly known from secondary hosts in the region]
	Pistacea (Galls)	Graminae
	Rhus	
	Ailanthus (Galls)	?
	Toona ciliata (Galls)	? Graminae

TABLE—2

Aphid species on Poplar Galls

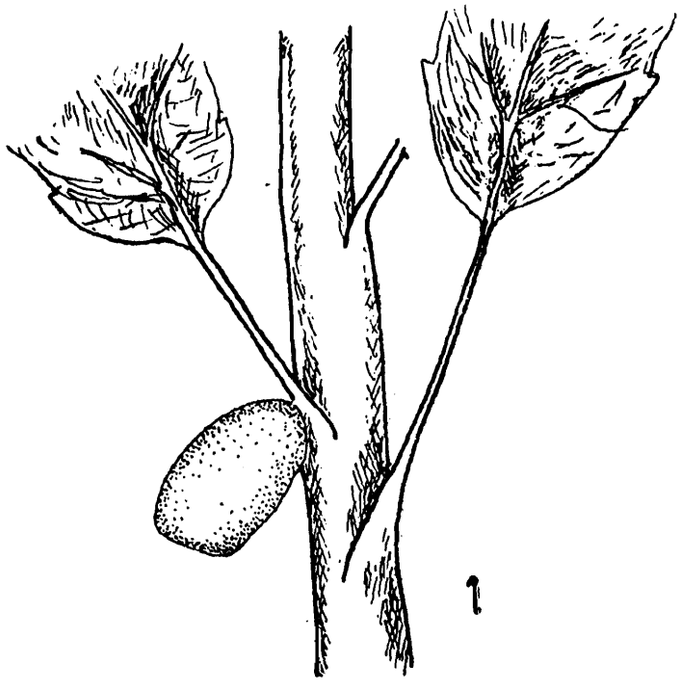
	Aphid species		Host Plant	First record
1.	*Epipemphigus imaicus* (Cholodkovsky) :	:	*Populus ciliata*	(Cholodkovsky, 1912)
2.	*Pemphigus immunis* Buckton	:	*Populus nigra*	(Buckton, 1897)
3.	*Pemphigus mordvilkoi* Cholodkovsky	:	*Populus ciliata*	(Cholodkovsky, 1912)
4.	*Pemphigus nainitalensis* Cholodkovsky	:	*Populus ciliata*	(Cholodkovsky, 1912)
5.	*Pemphigus napaeus* Buckton	:	*Populus euphratica*	(Buckton, 1897)
6.	*Pemphigus siphunculatus* Hille Ris Lambers	:	*Populus ciliata*	(Hille Ris Lambers, 1973)
7.	*Pemphigus indicus* Keiffer	:	Host indet	(Keiffer, 1908)
8.	*Pemphigus spyrotheceae* Passerini	:	*Populus nigra*	(Mathur & Sinch, 1959)
9.	*Pemphigus ignotus* Habib & Ghani	:	*Populus ciliata*	(Habib & Ghani 1970)
10.	*Pemphigus venosus* Habib & Ghani	:	*Populus ciliata*	(Habib & Ghani, 1975)
11.	*Pemphigus vesicarius* Passerini	:	*Populus* sp.	(Gulamullah, 1941)
12.	*Pemphigus* sp.	:	*Populus ciliata*	(New Record)

Galls and Aphids

1. Tribe **Pemphigini**

A. On **Populus** spp.

Four species of Poplars, *alba*, *ciliata*, *euphratica* and *nigra* grow in the Himalaya (Indo-Pakistan region), but 6 of the 12 Pemphigids species (Table 2) are known to form galls only on *Populus ciliata*, which is known to prevent soil erosion and is also used for match-industry (Habib & Ghani 1970). Further report of occurence of four of these Poplar-aphids, after their first record of incidence,



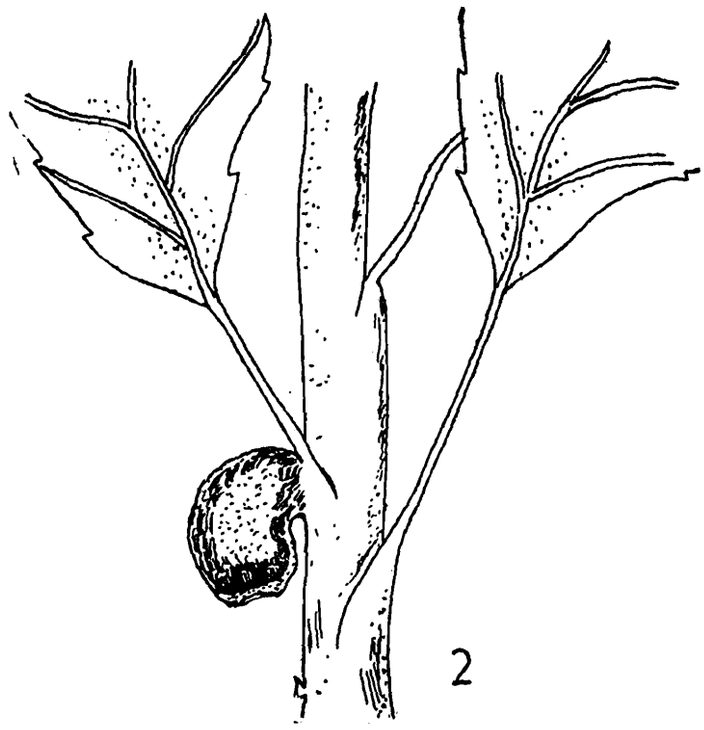
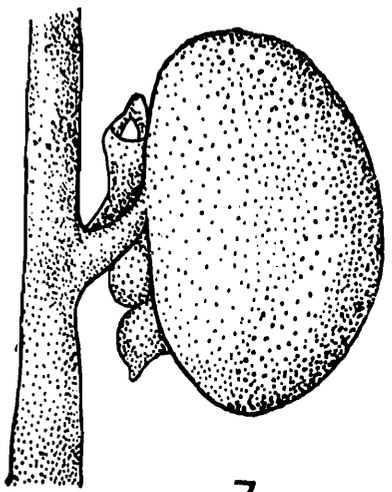


Fig. 1. Stem gall of *Pemphigus napeus* on *Populus* sp.
Fig. 2. Stem gall of *Pemphigus mordvilkoi* on *Populus* sp.
Fig. 3. Stem gall of *Pemphigus naintalensis* on *Populus* sp.
Fig. 6. Leaf gall of *Pemphigus indicus* on unidentified plant

is lacking (4, 7, 8, 11) and two species have only been recently recorded in Pakistan region (9,10) ; of these two, *venosus* is reported to form galls on twigs and branches (like *napaeus*, *mordvilkoi*, *nainitalensis* and *siphunculatus*) and *ignotus* is reported to form leaf-galls, as in the cases of most of the other pemphigids. The key includes 6 of the



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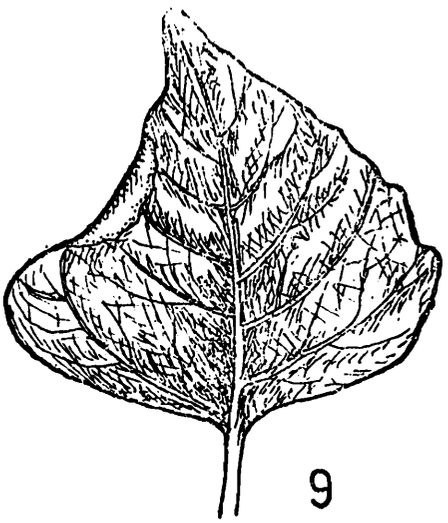

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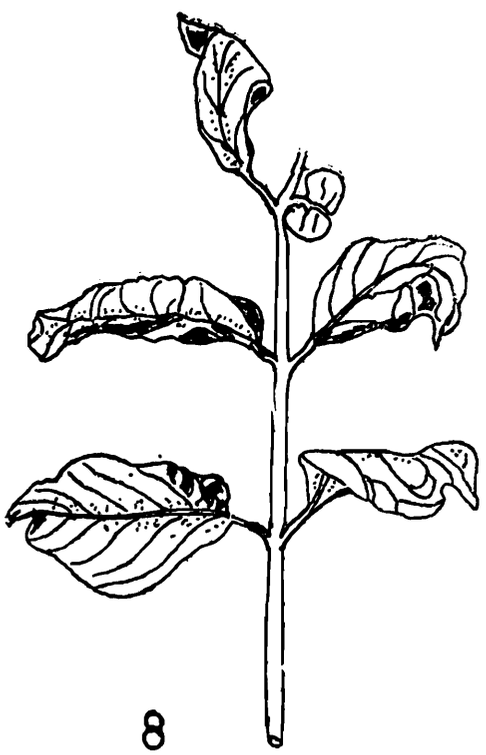

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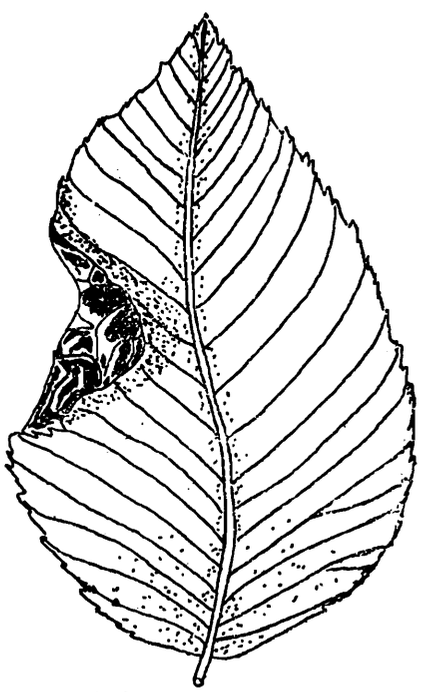

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Fig. 7. Leaf gall of *Pemphigus immunis* on *Populus* sp.

Fig. 8. Leaf gall of *Prociphilus alnifoliae caryae* on *Lonicera* sp.

Fig. 9. Leaf gall of *Thecabius affinis* on *Ranunculus* sp.

Fig. 10. Leaf gall of *Eriosoma ulmi* on *Ulmus* sp.

first seven species besides an unidentified *Pemphigus*, (no description of gall of *siphunculatus* is available) and excludes last 4 species, because of lack of sufficient report (8, 11 from Afghanisthan) or description (9, 10 from Pakistan) ; however detailed description of galls of *spyrothecae* Passerini, and *vesicarius* Passerini are available in Roberti (1938).

Galls on **Populus** spp.

1. Closed galls, on stem. ... 2

   On leaves. ... 4

2. Roundish or irregular, sessile, shining green, variegated with yellow or brown spots, distinctly veined, 25-75 mm, on *P. ciliata*, *P. nigra* ; Darkot Pass in N. W. Himalaya (Fig. 1). ... *Pemphigus napaeus* Buckton.

   Galls never veined as above ... 3

3. Subspherical or pyriform, sessile, usually, solitary, yellow or yellowish green, smooth walled, 10-30 mm in diameter with a large gall chamber. On *P. ciliata* ; Kumaon Himalaya to Kashmir (Fig. 2). ... *Pemphigus mordvilkoi* Cholodkovsky

   Subspherical, smooth, small, sessile, lateral, 1-2 per branch, 5-7 mm in diameter, much smaller than of *mordvilkoi* on *P. ciliata* ; N. W. Himalaya (Fig. 3). ... *Pemphigus nainitalensis* Cholodkovsky

4. On dorsal surface, at leaf base, reddish green, cystolith patterned. On *Populus ciliata* (Fig. 4). ... *Pemphigus* sp.

   Never on leaf base as above ... 5

5. Elongated finger like, reddish green, on dorsal surface of leaf, near midrib or on margin, chamber opens ventrally through a minute pore. On *P. ciliata* ; Northwest Himalaya and Sikkim (Fig. 5) ... *Epipemphigus imaicus* (Cholodkovsky).

   Never finger shaped as above ; very large sac like or pyriform gall on branches, hard, smooth, with ostiole at apex, and corrugated at the edges ; 25-50 mm long. On *P. euphratica* ; Kashmir Himalaya (Fig. 7) ... *Pemphigus immunis* Buckton

B. On **Lonicera** sp.

Gall formed by folding of entire leaf blade, forming, somewhat elliptical, irregular shaped structure. On *Lonicera quinquelocularis* ; Himachal Pradesh, (Fig. 8) ... *Prociphilus alnifolliae caryae* Baker & Davidson

C. On **Syringa** sp.

Gall hypophyllous, formed by simple leaf folding, appearing as a closed, marginal, tubular structure. On *Syringa emodi* ; Uttar Pradesh ... *Prociphilus xylostei* (de Geer)

D. On **Rananculus** sp.

Simple hypophylous (rarely epiphyllous) leaf folding to form a closed tubular marginal gall ; Uttar Pradesh (Fig. 9) ... *Thecabius affinis* (Kltb.)

E. On unidentified Plant

Irregular globose, lobed, with rugose surface, thick walled, with a large gall cavity, Eastern Himalaya (Fig. 6) ... *Pemphigus indicus* Keiffer

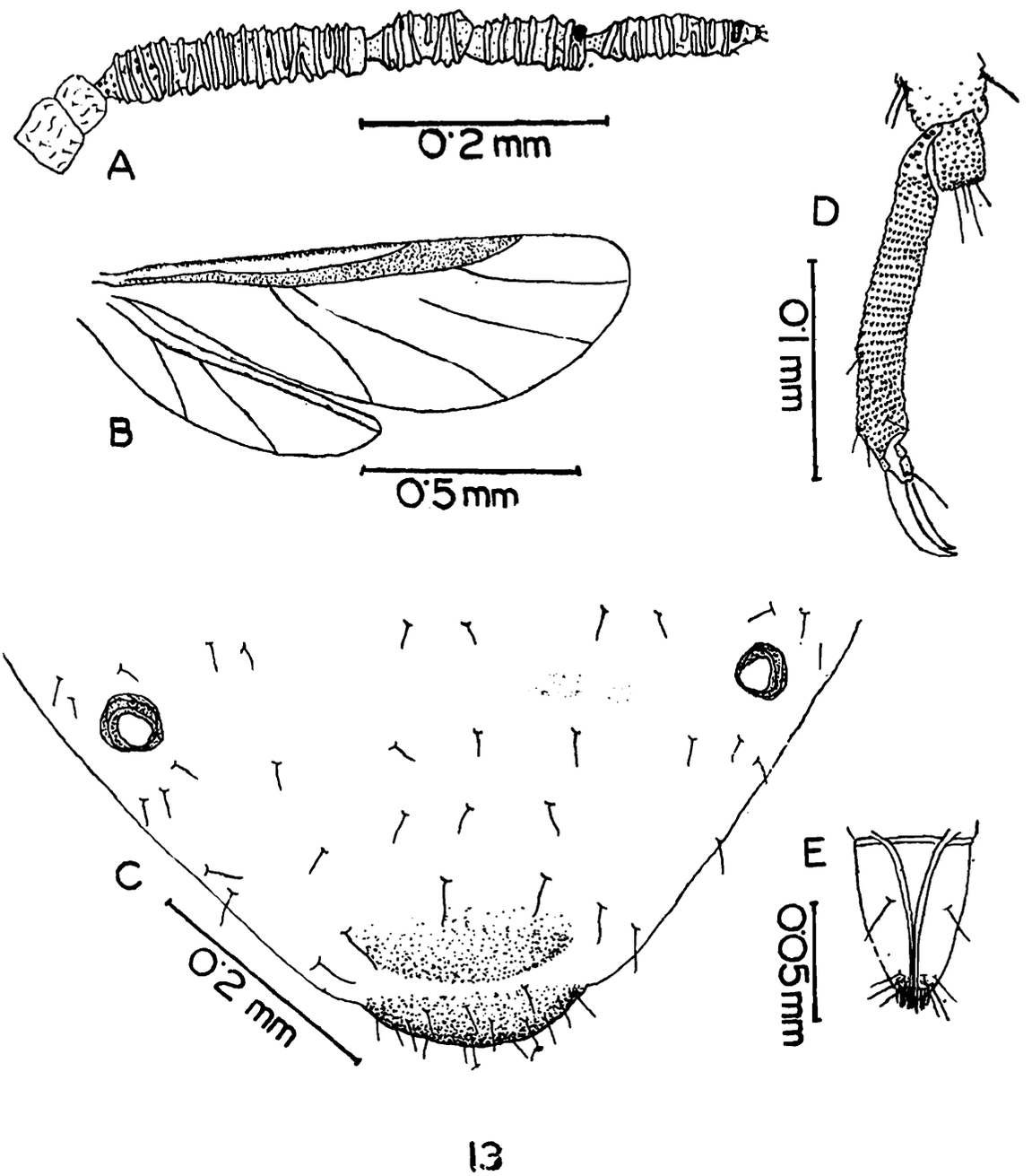

Fig. 13. *Kaltenbechiella carpinicola* sp. nov., alate viviparous female ; A. antenna, B. wings, C. posterior part of abdomen, D. second joint of hind tarsus, E. ultimate rostral segment.

II. Tribe **Eriosomatini**

A. On **Ulmus** spp.

Four species of *Ulmus* are known to grow in Indian region between 1700-2000 m. of which *Ulmus villosa* and *wallichiana* appear to be more common. Eight species of Eriosomatini (of Pemphiginae) (Table 3) are known to form galls on *Ulmus* in the region, of which five have been keyed below ; of the remaining species, no description of galls of *S. indica* Hille Ris Lambers and *T. polychaeta* Hille Ris Lambers is available ; galls of *lanuginosum* have been described from Europe by Hartig (1841).

Galls on **Ulmus** spp.

1. Simple leaf gall, without complex architecture, with a folding to form a closed tubular marginal hypophyllous structure. On *Ulmus montana* ; N. W. India. ... *Eriosoma phoenax* Mordvilko

   Leaf gall, with complex architecture ... 2

2. Gall twisted, spiral, formed of leaf folding or epiphyllous 3

   Gall bladder like ... 5

3. Large, epiphyllous, of various shape, ovoid, clavate, sometimes laterally compressed and lop sided with a short narrow neck, rugose, reddish brown, pubescent on inner wall ; On *Ulmus* sp. Afghanistan ... *Eriosoma lanuginosum* (Hartig)

   Galls spiral, twisted, never as above ... 4

4. Elliptical hard spiral gall with an elongate slit like opening on one side ; leaf margin ventrally folded. On *Ulmus wallichiana* ; N. W. India (Fig. 10) ... *Eriosoma ulmi* (Linnaeus)

   Gall with pouch or chamber, wall of which twisted clockwise and fringed to form a screwed—tubular gall ; on *Ulmus* sp., N. W. India (Fig. 11) ... *Eriosoma kashmiricum* L. K. Ghosh *et al.*

5. Reddish, conical bladder like, solitary, on dorsal leaf surface, on *Ulmus* sp. ; Kashmir (Fig. 10). ... *Tetraneura ulmi* Linnaeus

   Epiphyllous, conical, short, bladder like, greenish not less than 4-5 on single leaf, on *Ulmus* sp. ; Uttar Pradesh (Fig. 12) ... *Tetraneura nigriabdominalis* (Sasaki)

B. On **Carpinus** sp.

A new aphid species of *Kaltenbachiella* viz. *Kaltenbachiella carpinicola* sp. nov. has been collected from open galls on leaf blades, appearing as swollen cup-shaped pouch or cavity, surrounded by thick leaf tissue. Description of the new species is given below.

Fig. 14. Leaf gall of *Baizongia pistaciae* on *Pistacia* sp.

Kaltenbachiella carpinicola sp. nov. (Fig. 13)

Alate viviparous female : Body 2.23-2.55 mm. long with 0.89-1.24 mm. as maximum

TABLE—3

Aphid species in *Ulmus* Galls

	Aphid species		Host Plant	First Record
1.	*Eriosoma* (*Schizoneura*) *kashmiricum* L. K. Ghosh et. al.	—	*Ulmus* sp.	(L. K. Ghosh et. al. 1976)
2.	*Eriosoma lanuginosum* (Harting)	—	*Ulmus* sp.	(Gulamullah, 1941)
3.	*Eriosomae* (S.) *phaenax* Mordvilko	—	*Ulmus montana*	(New record)
4.	*Eriosoma* (S.) *ulmi* Linnaeus	—	*Ulmus wallichiana*	(New record)
5.	*Schizoneurella indica* H. R. L.	—	*Ulmus villosa*	(H. R. L. 1973)
6.	*Tetraneura* (*Tetraneurella*) *nigriadominalis* (Sasaki)	—	*Ulmus* sp,	(New record)
7.	*Tetraneura* (*Tetraneurella*) *polychaetn* H. R. L.	—	*Ulmus villosa*	(H. R. L. 1970)
8.	*Tetraneura* (*Tetraneura*) *ulmi* (Linnaeus)	—	*Ulmus* sp.	(New record)

width. Head brown to blackish brown; vertex slightly rugose with many scattered wax pores and with 4 pairs of short hairs and a single hair placed laterad, with acute to acuminate apices, longest one about 11-14 μ long and about 0.50-0.66 times as long as the basal diameter of the antennal segment III; dorsal median suture present on posterior half of the head; lateral and median frontal prominance not developed. Eyes with indistinct occular tubercles, median ocellus not viewed from the dorsal side. Antennae 6 segmented, brown to blackish brown, about 0.36-0.42 times as long as the body; segments I and II each with 4 short, pointed hairs; hairs on the flagellum sparse, acute, longest one on segment III about 7-11 μ and 0.45-0.50 times as long as the basal diameter of the segment; secondary rhinaria non-ciliated, annular, nearly encircling the width of the segments; segment III with 20-29, IV with 7-10, V with 10-13 and VI with 15-17 secondary rhinaria; primary rhinaria ciliated; processus terminalis about 0.14-0.18 times as long as the base of segment VI. Ultimate rostral segment about 0.54-0.62 times as long as the second segment of hind tarsus, bearing 2-4 accessory hairs. Thorax blackish brown and with scattered wax pores particularly on mesothoracic lobes. Abdomen pale brown, tergum membranous, dorsal hairs thin with acuminate apices, mostly arranged in rows, anterior tergite with 10-12 hairs, usually with 1 pair of spinal, 1 pair of pleural, and 2-3 pair of marginals, longest hair on anterior tergites about 0.22-30 μ long and about 1.0-1.5 times as long as the basal diameter of antennal segment III; 7th tergite with 8-10 hairs and 8th with 6 hairs, longest one about 26-30 μ and 29-33 μ long and about 1.3-1.6 times and 1.3-1.7 times as long as the basal diameter of antennal segment III, respectively. Siphunculi black, sclerotized, ring like, about 0.029-0.044 mm in diameter. Cauda semilunar with 12-14 hairs. Subanal plate sclerotised slightly indented with 29-31 hairs. Subgenital plate with about 24 pairs of hairs in 2-3 rows on posterior margin. Ventral hairs stouter than dorsal hairs. Legs brown, femora stout scabrous, femoral hairs short and pointed, tibiae with long and fine hairs, longest hair on hind tibiae 23-26 μ long, 0.58-0.66 times

Measurements in mm :

Specimen No.	Length	Width	Antena	Antennal segments III	IV	V	VI	urs.	ht_2
1.	2.23	1.07	0.95	0.34	0.11	0.16	(0.16+ 0.03)	0.09	0.16
2.	2.33	1.13	0.93	0.35	0.11	0.13	(0.16+ 0.03)	0.09	0.16
3.	2.20	1.08	0.93	0.34	0.11	0.14	(0.16+ 0.03)	0.09	0.16
4.	2.34	0.89	0.96	0.35	0.12	0.16	(0.17+ 0.03)	0.09	0.15

(1. Holotype, 2-4, Paratypes, alate viviparae female, from *Carpinus* sp. Trijuginarayan, UTTAR PRADESH, INDIA, 5. 6. 1978. Coll. *D. K. Bhattacharya*).

as long as the diameter at the middle of hind tibiae ; tarsi and anterior most portion of tibiae spinulose, spinules on tarsi arranged in rows. First tarsal segments with 4, 4, 5. Empodial hairs 23-30 μ long, 0.63-0.69 times as long as the claws. Forewing with media simple, veins little dusky.

Type material : *Holotype* ; alate viviparous female from *Carpinus* sp. Trijuginarayan, INDIA : UTTAR PRADESH, 5. 6. 1978 (Coll. *D. Bhattacharya*).

Paratypes : 13 alate viviparous females and 3 alatoid nymphs, collection data as in the holotype.

Remarks : Four valid species of *Kaltenbachiella* Schoutedon 1906, are now recognised, viz. *elshotriae* (Shinji) from Japan and Sri Lanka, *japonica* Matsumura from Japan, *pallida* (Haliday) from Holoarctic region and Africa, *ulmifusa* (Walsh & Riley) from U.S.A. The typical life cycle (e.g. *pallida*) involves alternation between galls of *Ulmus* spp., and roots of Labiatae but some like *japonica* Matsumura and perhaps also *elshotriae* (Shinji) complete their life cycle on *Ulmus* and *Elshotzia*. The present collection from *Carpinus*, where these insects form galls, indicate the existence of yet another species, completely different in its host-association, from all other known species. The species, seems closest to North American *ulmifusa* but differs in much larger size of body, in ratio of body to antenna, ultimate rostral segment to second joint of hind tarsus and in having more number of secondary rhinaria etc.

The type materials are deposited in the Department of Zoology, University of Kalyani, except 4 paratypes which are with Fauna Unit, Zoological Survey of India, Calcutta.

III. Tribe **Fordini**

E. On **Pistacia** (Das 1918)

Elongate horn shaped, pod like leaf gall, may be twisted, straight or curved, green or pink, old galls remaining often on trees ; may often be very long and contains hundreds of aphids, N. W. India (Fig. 14). ...

GHOSH *et al* PLATE IV

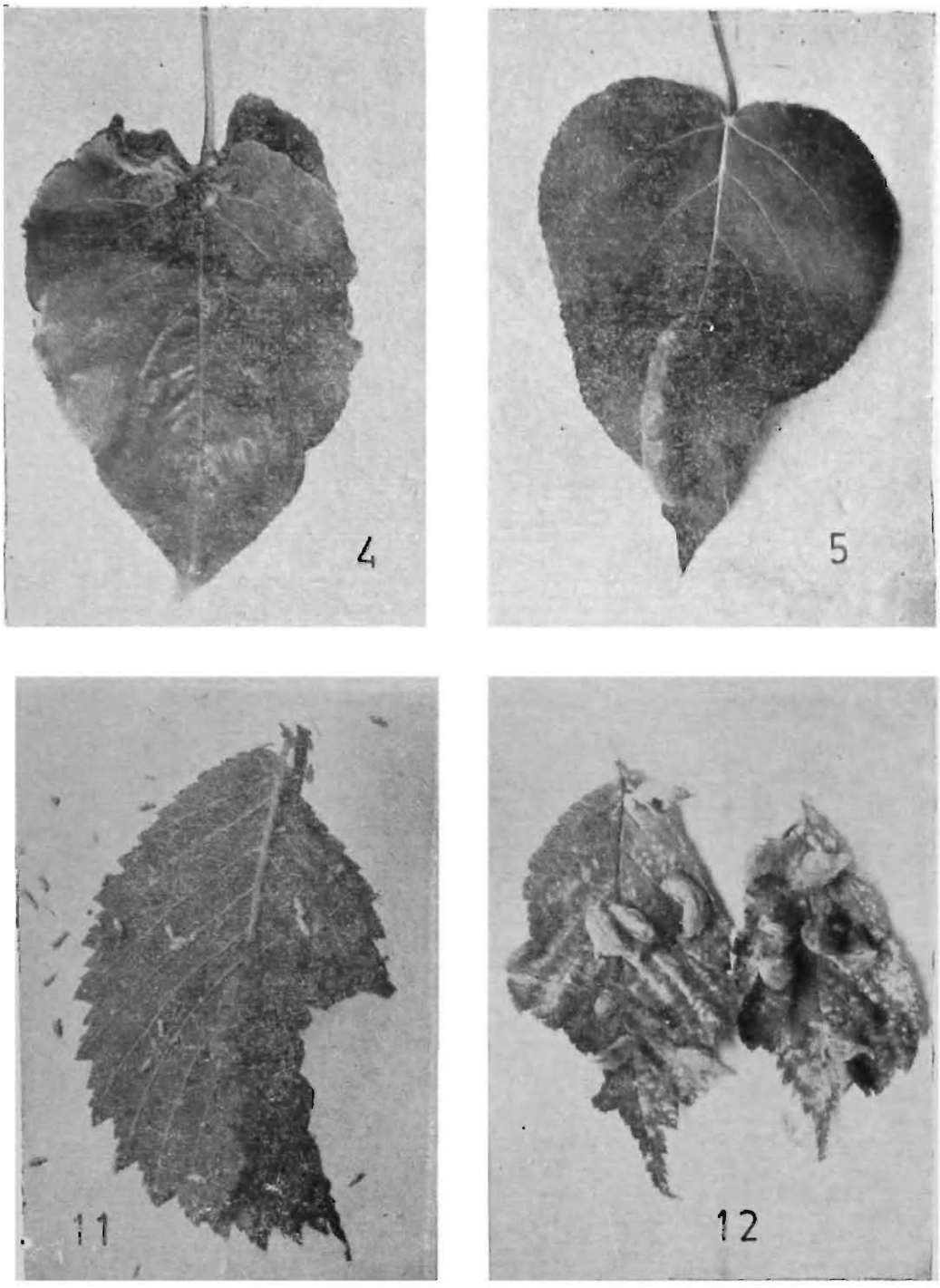

Fig. 4. Leaf gall of *Pemphigus* sp. on *Populus* sp.

Fig. 5. Leaf gall of *Epipemohigus imaicus* on *Populus* sp.

Fig. 11. Leaf gall of *Eriosoma kashmiricum* on *Ulmus* sp.

Fig. 12. Leaf gall of *Tetraneura nigriabdominalis* on *Ulmus* sp.

... *Baizongia pistaciae* (Linnaeus).

F. On **Ailanthus glandulosus** (Chowdhury *et al.*)

Petiole gall, elongate without specific shape with a single cavity. Himachal Pradesh..... *Kaburagia aillanthi* Chowdhury *et al.*

G. On **Toona ciliata** (new record)

Epiphyllous, leaf-folding, covering, brick-red, elliptical, pouch gall on the margin of leaf blade. Uttar Pradesh...*Forda orientalis* George

MATERIAL EXAMINED FROM GALLS

1. *Baizonga pistaciaie* Linnaeus : 8 alatae and nymphs, INDIA : U. P.: Dhakuri, 25.×.1970. Coll. *S. Chakrabarti.*
2. *Eriosoma ulmi* Riley : 3 apterae, 4 alatae and nymphs ; INDIA : KASHMIR ; 22.v.1979. Coll. *D. K. Bhattacharya.*
3. *Eriosoma kashmiricum* L. K. Ghosh *et al.* : One aptera, many alatae and nymphs, INDIA : U. P. ; Ghangaria, 10. vi. 1978. Coll. *S. Chakrabarti.*
4. *Eriosoma phoenax* Mordvilko : Many apterae, 5 alatae and nymphs, INDIA : U. P. ; Bhowali, 24. v. 1969. Coll. *S. Chakrabarti.*
5. *Epipemphigus imaicus* Chelodkovsky : Many apterae, alatae and nymphs, INDIA : U. P. ; Mussoorie, 20. vi. 1975 Coll. *S. Chakrabarti* ; 21. vi. 1976 ; Coll. S. P. Maity ; HIMACHAL PRADESH ; Simla, 16. v. 1979. Coll. *D. K. Bhattacharya.*
6. *Forda orientalis* George : Many apterae, 7 alatae and nymphs, INDIA : U. P. ; New Forest, Dehradun, 21. vi. 1976, Mussorie, 23. vi. 1976. Coll. *S. Chakrabarti.*
7. *Kaburagia ailanthi* Chowdhury *et al.* : 4 alatae and nymphs, INDIA ; U. P. ; Sundardonga valley, 18.x. 1970. Coll. *A. N. Chowdhuri.*
8. *Kaltenbechiella carpinicola* sp. nov. : 6 alatae, INDIA : U. P. ; Trijuginarayan, 5. vi. 1978. Coll. *D. K. Bhattacharya.*
9. *Pemphigus mordvilkoi* Cholodkovsky : Many apterae, alatae and nymphs, INDIA : U. P. ; Mussooree, 21. vi. 1976. 16, x. 1976, 19. x. 1976. Coll. *S. P. Maity.*
10. *Pemphigus* sp. : 2 apterae and nymphs, INDIA ; U. P. ; Ghangaria, 10. vi. 1978. Coll. *S. Chakrabarti*, Lanka 8. vi, 1980, Coll. *D. k. Bhattacharya.*
11. *Prociphilus alnifoliae caryae* Baker & Davidson : A alatae and nymphs, INDIA : HIMACAL PRADESH Simla, 13. v. 1979. Coll. *S. P. Maity.*
12. *Prociphilus xylostei* (de Geer) : Meny apterae and 10 alatae and nymphs, INDIA : U. P. ; Ghangaria, 13. vi. 1978. Coll. *D..K. Bhattacharya.*
13. *Tetraneura ulmi* Linnaeus : Many apterae, 4 alatae and nymphs, INDIA : KASHMIR, 22. v. 1979. Coll. *D. K. Bhattacharya.*
14. *Tetraneura nioriabdominails* (Sasaki) : 2 apterae and nymphs, INDIA ; U. P. ; Ghangaria, 10. vi. 1978. Coll. *D. K. Bhattacharya.*
15. *Thecabius affinis* Kaltenbaci : 5 apterae and nymphs, INDIA ; U. P. ; Kedarnath, 3. vi. 1978. Coll. *S. Chakrabarti.*

DISCUSSION

Schoutedon (1905) described a new genus and a species *Ceratopemphigus zehntneri*, from 'large foliate galls on undetermined shrubs', and opined that the 'shrub is possibly *Pistacia*'. Howard (1922) and Mani (1948) quoted from Schoutedon (op. cit.) ; Doncaster (1956) redescribed the species from another plant, *Brunfelsia uniflora* and did not mention any thing about the galls. It is known that members of Pemphiginae have Poplar (Pemphigina) or Conifers (Prociphilina) as Primary host and have never been reported from *Pistacia* ; as such leaf gall on undetermined plant may not belong to *Pistacia* ; in case, *Brunfelia* is recorded as secondary host, the genus and species could clearly be more closely correlated with *Prociphilus* (which has an array of primary hosts), as Doncaster (op. cit.) has already shown it taxonomically. But the question remains about the identity of the plant on which foliage gall were found.

Mani (1973) in his pioneering work on 'Plant Galls of India', listed four galls caused by unidentified aphids on *Ulmus wallichiana* (Gall No. 493), *Ulmus laevigata* (Gall 591), *Populus nigra* (Gall 590) and *Populus ciliata* (Gall 592) : All these must have been formed by some Pemphigids as no other aphid would form gall on Elms and Poplars ; the gall 493 may belong to a *Tetraneura* species, while gall 591 appear to be formed by *Schizoneura* species ; Mani, (op. cit.) also mentions a gall, i.e., 112, to be formed by *Schizoneura campestris* but no such species is known in Aphididae and this may refer to *Eriosoma* (*S.*) *ulmi*. Gall 590 on *P. nigra* and 592 on *P. ciliata* appear to be formed by some *Pemphigus* species (as it is, only two species *Pemphigus immunis* Buckton and *Pemphigus spyrotheceae* Passerini, are known from *P. nigra* and at least 6 spp. are known from *P. ciliata*, (see Table 1).

It may be mentioned that *Dasia aedificator* (p. 320, Mani) on *Pistacia integerrima* and unknown aphid on *Pistacia khinjuk*, should both refer to *Baizongia pistaciae* (Linnaeus), as the galls described therein could only be formed by this aphid species.

Two galls on Rosaceae (Gall 422, 417) formed by unidentified aphids have been reported by Mani (op. cit.) which may be caused by some *Schizoneura* species (as secondary host) or even by *Brachycaudus* or some *Myzus* species, as often members these genera show preference for Rosaceaeus hosts.

The present paper outlines several aspects which need further investigation. Records of galls appear to be very few and from restricted collections localities ; as most of the plant species occurs in wide spread areas of temperate climate in North-west India, it is most likely that a more extensive survey of aphid-galls may reveal a better picture of occurrence of these galls and aphid species. This may also help to locate primary host of many of the other species, which have so far been reported only from secondary hosts ; new records of at least 8 species from plant-galls in this paper through recent surveys is notworthy. Biological knowledge of many pemphigid species in the region remain far from complete and correlation of material from both primary (wherever existent) and secondary host could only solve the problem.

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