

## NOTES ON THE MOSQUITOES OF NEPAL I. NEW COUNTRY RECORDS AND REVISED *AEDES* KEYS (DIPTERA, CULICIDAE)<sup>1</sup>

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**ABSTRACT:** Additional collections of mosquitoes in the environs of Hetaura, Makwanpur District, and Birgunj, Bara District during 1990, resulted in the discovery of 4 new country records and the collection of the immature stages of 7 species previously known from Nepal only in the adult stage. Revisions and additions to the Darsie/Pradhan keys are presented so that the species new to Nepal can be identified. Also, revised *Aedes* keys are presented.

### INTRODUCTION

Darsie and Pradhan (1990) published an extensive account of the mosquitoes of Nepal, including all previous published works. We reported 130 species in 14 genera. Another genus, *Tripteroides*, was included in our report without a species being named. One of the 4 species which we are reporting as new to Nepal belongs to this genus. We are adding notes on mosquito habitats sampled, based on recent collections made in 1990.

Only culicine and sabethine mosquitoes are included in this account. Peters and Dewar (1956), Joshi et al. (1965), Pradhan and Darsie (1989, 1990) have previously published records of culicine, sabethine and toxorhynchitine species occurring in Nepal.

Certain habitats occupied by immature mosquitoes had not previously been sampled, such as, leaf axils of plants, bamboo stumps and roots of aquatic plants. Results of the investigation of

these habitats were quite rewarding. In addition to the new country records, we collected larvae of 7 species previously known from Nepal only as adults.

The purpose of the study was to sample mosquito breeding habitats in and near Hetaura, Makwanpur District, Narayani Zone, located in the inner terai at an elevation of 187 m. Also, collections were made on 1 occasion near Birgunj, Bara District, Narayani Zone, close to the Indian border at an elevation of 100 m. Adults, captured by hand aspirator, and larvae were mounted for study. Certain larvae of the genera *Aedes* and *Heizmannia* could not be identified with existing keys. They are believed to be either undescribed immatures of known species or species new to science. Individual rearing will be made in the future to determine their identity. Their existence is mentioned here by listing them simply as Species A, B or C. The symbols and abbreviations used below are ♀ = adult female, L = larva and an asterisk preceding the scientific name indicates species whose larvae were collected for the first time in Nepal.

### COLLECTION SITES AND RECORD OF SPECIES

1. Nawalpur, 5 km west of Hetaura, IX-4-90 and IX-11-90, bamboo thicket, females attracted to humans, larvae from stumps: *Aedes* (*Nemelaniconion*) *lineatopennis* (Ludlow) - 1♀; *Aedes* sp. A - 5L; *Armigeres* (*Armigeres*) *kesseli* Ramalingum - 1♀; \**Armigeres* (*Armigeres*) *magnus* (Theobald) - 27♀, 9L; *Armigeres* (*Armigeres*)

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*theobaldi* Barraud - 1♀.

2. Jyamere, 15 km west of Hetaura, IX-4-90, axils of *Collocasia esculenta* var. *illustris* Hill (elephant ear plant): *Aedes (Stegomyia) albopictus* (Skuse) - 1♀, 3L; *Aedes* sp. A - 5L; \**Malaya genurostris* Leicester - 5♀, 5L; *Malaya jacobsoni* (Edwards) - 1♀, 10L NEW COUNTRY RECORD.

3. Ratamate, 2 km south of Bhainse, 500 m, about 50 m above the main highway (the Tribuvan Raj Path), IX-4-90 and IX-11-90: from bamboo stumps: *Ae. albopictus* - 6L; *Aedes (Stegomyia) pseudoalbopictus* (Borel) - 1L NEW COUNTRY RECORD; *Aedes* sp. B - 1L; *Aedes* sp. C - 1L; *Heizmannia* sp. A - 15L; *Heizmannia* sp. B - 2L; *Tripteroides (Rachionotomyia) aranoides* (Theobald) - 4♀, 24L NEW COUNTRY RECORD. From *Collocasia* spp.: *Aedes (Finlaya) formosensis* Yamada - 8L NEW COUNTRY RECORD; *Ml. genurostris* - 1L; *Ml. jacobsoni* - 2L.

4. Hetaura, IX-2-90, near the Hetaura Training Center, Nepal Ministry of Health (HTC), Hindu Temple, a brick and concrete cavity near entrance, with fresh and decaying flowers: *Ae. albopictus* - 7L; *Aedes (Finlaya) pseudotaeniatatus* (Giles) - 1L; *Aedes* sp. A - 6L; \**Armigeres (Leicesteria) dentatus* Barraud - 1L; \**Armigeres (Armigeres) durhami* Edwards - 8L.

House 300 m east of the main street, IX-2 to IX-10-90, females attracted to humans: *Ae. albopictus* - 6♀; *Ae. pseudotaeniatatus* - 9♀; *Aedes*

(*Aedimorphus*) *vittatus* Bigot - 4♀; *Ar. kesseli* - 3♀; *Armigeres (Armigeres) subalbatus* (Coquillett) - 1♀.

Contaminated ground pool in an open lightly vegetated field in full sun, IX-12-90: *Culex (Culex) fuscocephala* Theobald - 3L; *Culex (Culex) gelidus* Theobald - 17L; *Culex (Culex) whitei* Barraud - 1L.

5. Birgunj, IX-5-90, pond covered with water hyacinth, (*Eichornia* spp): \**Mansonia (Mansonioides) annulifera* (Theobald) - 6L; \**Mansonia (Mansonioides) indiana* Edwards - 5L; \**Mansonia (Mansonioides) uniformis* (Theobald) - 4L.

Evening resting and human bait collections: *Ma. indiana* - 12♀; *Ma. uniformis* - 10♀; *Culex (Culex) quinquefasciatus* Say - 1♀.

## IDENTIFICATION OF SPECIES NEW TO NEPAL

The 4 newly recorded species can be identified using the keys of Darsie and Pradhan (1990) with the modifications and additions given below.

*Aedes formosensis* and *Aedes pseudoalbopictus*. In the key to adult females these species will proceed to couplet 12. The proboscis is pale-scaled ventrally in *Ae. formosensis* and dark-scaled in *Ae. pseudoalbopictus*, therefore, they will continue to couplet 18. The rest of the key needs to be revised as follows:

- 18(12). Scutum with thin median line of yellowish scales forked at prescutellar space ..... *formosensis*  
Scutum with other scale pattern, without thin median line ..... 19
- 19(18). Hindtarsomeres with narrow basal pale-scaled bands on at least some segments; fore- and midlegs with claws toothed ..... 20  
Hindtarsomeres with broad basal pale-scaled bands on at least some segments; fore- and midlegs with claws simple ..... 21
- 20(19). Abdominal terga usually with median pale-scaled patches, not forming complete transverse bands; scutum with large pale-scaled patch anteriorly ..... *gubernatoris*  
Abdominal terga with complete pale-scaled transverse bands; scutum with pale scales at scutal angles ..... *caecus*
- 21(19). Dorsocentral setae present ..... 22  
Dorsocentral setae absent ..... 25

- 22(21). Scutum without patch of broad flat white scales over wing root ..... 23  
 Scutum with patch of broad flat white scales over wing root ..... 24
- 23(22). Scutum with patch of broad dark scales on either side of  
 prescutellar space; postspiracular area scaled ..... *pseudalbopictus*  
 Scutum without patch of broad scales on either side of  
 prescutellar space; postspiracular area bare ..... *subalbopictus*
- 24(23). Scutum with small patch of white scales on scutal angle;  
 midfemur with scattered white scales on anterior surface ..... *unilineatus*  
 Scutum without patch of white scales at scutal angle; midfemur  
 without scattered white scales on anterior surface ..... *albopictus*
- 25(21). Scutum with anteromedian white-scaled patch wider than long,  
 reaching scutal fossa laterally; some white scales in antealar  
 area broad, flat ..... *gardnerii imitator*  
 Scutum with anteromedian white-scaled patch longer than wide,  
 not reaching to scutal fossa; all white scales in antealar area  
 narrow ..... *w-albus*

It is necessary to revise the key to the fourth instar larvae of *Aedes*. *Aedes vittatus* was inadvertently misplaced, *Ae. formosensis* and *Ae. pseudalbopictus* need to be added and some couplets require changes. Thus this revision replaces the *Aedes* larval key in Darsie and Pradhan (1990).

### KEY TO THE FOURTH INSTAR LARVAE OF GENUS *AEDES*<sup>5</sup>

1. Pecten with some apical spines, widely spaced ..... 2  
 Pecten with spines more or less evenly spaced ..... 8
- 2(1). Siphon spiculate apically and sometimes with patches of aculeae  
 dorsally and ventrally ..... *caecus*  
 Siphon smooth ..... 3
- 3(2). Head subquadrate, squared anteriorly; comb scales more than 50 ..... *scatophagoides*  
 Head more triangular, rounded anteriorly; comb scales usually  
 no more than 25 ..... 4
- 4(3). Siphon short, index 3.0 or less; comb scales numbering 6-10 ..... 5  
 Siphon long, index at least 5.0; comb scales numbering 14 or  
 more ..... 7
- 5(4). Setae 5,6-C single; saddle covering no more than 0.5 of segment X ..... *vittatus*  
 Setae 5,6-C with 3 or more branches; saddle almost encircling  
 segment X ..... 6
- 6(5). Setae 5,6-C 3-branched, with 1 branch noticeably longer and  
 stouter, others shorter, weaker ..... *indicus*  
 Setae 5,6-C with branches about equal in length and thickness,  
 usually with 4 or more branches ..... *lineatopennis*

<sup>5</sup>Partially adapted from Barraud (1934), Huang (1972, 1977a,b, 1979), Knight (1968), Reinert (1973) and Tyson (1970). The larva of *Ae. punctifemoris* is unknown.

7(4).	Comb scales evenly fringed with subequal spicules; siphon index 5.0-5.6 .....	<i>pipersalatus</i>
	Comb scales with prominent apical spine and small basolateral spicules; siphon index 7.0 or greater .....	<i>pallidostriatum</i>
8(1).	Comb scales with prominent apical spine .....	9
	Comb scales fringed apically with subequal spicules .....	14
9(8).	Seta 4-C long, almost as long as seta 6-C .....	10
	Seta 4-C small, much shorter than seta 6-C .....	11
10(9).	Seta 4-X attached to poorly developed grid, basal-most seta short, about 0.5 length of seta 1-X .....	<i>gardnerii imitator</i>
	Seta 4-X attached to well developed grid, basal-most seta almost as long as seta 1-X .....	<i>w-albus</i>
11(9).	Abdominal segments with some stellate setae .....	<i>unilineatum</i>
	Abdominal segments without stellate setae .....	12
12(11).	Siphon acus present; pecten spines 3-6, each spine short and stout .....	<i>pseudalbopictus</i>
	Siphon acus absent; at least 8 pecten spines, each spine long, 4.0 longer than wide, or more .....	13
13(12).	Saddle completely encircling abdominal segment X, seta 2-X usually single .....	<i>subalbopictus</i>
	Saddle not encircling X; seta 2-X usually double .....	<i>albopictus</i>
14(8).	Comb with fewer than 16 scales, in single row .....	15
	Comb with 22 or more scales in double row or triangular patch .....	17
15(14).	Seta 6-C with 4-10 branches; comb scales with apical spine more than 10 times length of subapical spicules .....	<i>albolateralis</i>
	Seta 6-C with at most 3 branches; comb scales with apical spine only 2-4 times length of subapical spicules .....	16
16(15).	Seta 6-C single, 2.0 or more length of seta 5-C; seta 10-VII double; median filaments of lateral palatal brush pectinate .....	<i>annulirostris</i>
	Seta 6-C double or triple, less than 2.0 length of seta 5-C; seta 10-VII single; median filaments of lateral palatal brushes simple .....	<i>thomsoni</i>
17(14).	Siphon with seta 1-S arising within pecten .....	18
	Siphon with seta 1-S arising distal to pecten .....	19
18(17).	Seta 1-A single; comb with 40 or more scales .....	<i>pseudotaeniatus</i>
	Seta 1-A with 2-3 branches; comb with 27 or fewer scales .....	<i>chrysolineatus</i>
19(17).	Seta 6-C with 2-4 branches; setae 4,5,6-C placed far forward in head; seta 1-A double .....	<i>pulchriventer</i>
	Setae 6-C and 1-A single; setae 4,5,6-C near middle of head .....	20
20(19).	Seta 1-C stout, blunt apically .....	21
	Seta 1-C fine, long, attenuated apically .....	22
21(20).	Seta 2-X double .....	<i>assamensis</i>
	Seta 2-X with 4 or more branches .....	<i>khazani</i>

- 22(20). Seta 6-C longer than length of head ..... *greenii*  
 Seta 6-C no longer than length of head ..... 23
- 23(22). Setae 4,5,6-C close together, about equidistant; antennae at least  
 0.66 length of head; comb scales 60-70 ..... *dissimilis*  
 Seta 5-C removed posteriorly from setae 4,6-C; antenna about 0.2  
 length of head; comb scales 30-40 ..... *gubernatoris*

*Malaya jacobsoni*. No key to the species of *Malaya* was given in the Darsie and Pradhan (1990) keys since only 1 species was known in

Nepal. The following keys can be used to separate the 2 species now being reported, using information from Barraud (1934).

**Adult Female.**

- Head with row of silvery scales between eyes; clypeus and most of proboscis pale yellow to white ..... *genurostris*
- Head without scales between eyes; clypeus and most of proboscis tan to dark brown ..... *jacobsoni*

**Fourth Instar Larvae**

- Pecten spines and comb scales with prominent bare apical spines ..... *jacobsoni*
- Pecten spines and comb scales fringed with spicules apically ..... *genurostris*

*Tripteroides aranoides*. This new record for Nepal is the only species of the genus known in the country, therefore, the generic key published earlier will suffice to identify it. However, some outstanding characters of the life stages will be helpful to recognize it in Nepal. The reader is referred to Mattingly (1981).

**Adult Female:** *Tripteroides aranoides* belongs to the *aranoides* Group whose adult females are difficult to separate. The specimens in our collection have a scutum covered with broad, brown concolorous decumbent scales. The abdomen is dark-scaled above and pale-scaled ventrally with a straight line where they meet laterally. The proboscis is unusually long, about 0.6 length of the body.

**Fourth Instar Larvae:** The larva of *Tp. aranoides* is very hairy in appearance because of the many stellate setae on the thorax and abdomen. It is distinguished from the other species of the subgenus [except *ceylonensis* (Theobald)] by the short seta 4-X, the comb composed of long and short scales attached to a comb plate, the long comb scales bare or with a fringe restricted to base, and the large spicules on the posterior border of the saddle sometimes fringed on one side as in some Nepal specimens.

There appears to be no means of separating larvae of *Tp. aranoides* and *Tp. ceylonensis*. However, Mattingly (1981) points out that the pupae are distinct. We have 2 pupae, from which adults were reared, whose paddles are long and pointed at the tip as in *Tp. aranoides*, rather than short and bluntly rounded apically, as in *Tp. ceylonensis*. Therefore we are confident that the *Tripteroides* collected from bamboo stumps in Ratamate are indeed *Tp. aranoides*.

**COMMENTS ON OTHER MOSQUITOES REPORTED FROM NEPAL**

*Aedes (Finlaya) greenii* (Theobald). This species was listed as *Aedes (Finlaya) aureostriatus* var. *greenii* (Theobald) by Darsie and Pradhan (1990). The variety was raised to specific rank by Harrison et al. (1991).

*Anopheles (Anopheles) fragilis* Giles [complex]. We reported this species from Nepal (Darsie and Pradhan 1990) based on 2 males deposited in the British Museum (Natural History). We have not examined them, however, Harrison et al. (1991) have pointed out that characters used to separate male genitalia from

other members of the *aikenii* Group are unreliable. Furthermore, they stated that Nepal is far removed from its known range. We are therefore deleting it from the Nepal mosquito fauna.

*Anopheles (Anopheles) gigas* Giles [complex]. The taxon reported by Darsie and Pradhan (1990) as *An. gigas* var. *baileyi* Edwards was elevated to specific status by Harrison et al. (1991).

Regarding the records of the *gigas* complex in Nepal, as reported by Darsie and Pradhan (loc. cit.), we now believe that the type form does not occur in Nepal. Upon reexamination, none of the larvae collected from Jumla District have the type form characters, i.e., seta 3-C branched and seta 4-C single (Puri 1960). Also, the type form is reported to be restricted to South India (Ramachandra Rao 1981). It appears impossible to separate the larvae of the other 2 taxa of the complex known from Nepal, *An. baileyi*, and *An. gigas* var. *simlensis* (James). Most probably they are *An. gigas* var. *simlensis* rather than *An. baileyi* based on distribution and the fact that the latter is allopatric in relation to the other members of the complex (Harrison et al. 1991). Further study of the Jumla larvae reveal that they are conspecific, especially examining setae 3-C, 4-C, 2-II and 6-V, structures purported to be useful in separating larvae of the complex (Christophers 1933, Puri 1960). Individual rearings will be needed to determine positively which *An. gigas* complex taxa occur in Nepal. We believe that *An. baileyi* and var. *simlensis* are part of the Nepal mosquito fauna, based on adult identification, but their precise distribution in the country awaits further collecting.

*Anopheles (Cellia) filipinae* Manalang. Pradhan and Brydon (1960) reported a single female of this species from Lamjung District in north-central Nepal. The specimen is not available for study and no other specimens have been collected in Nepal. This coupled with the knowledge that it could have been a female of *An. aconitus* Doenitz with an entirely dark-scaled proboscis gives support to the view that it does not occur in Nepal. Harrison (1980) recorded 2 of 1165 females of *An. aconitus* from progeny rearings with a dark proboscis. Also it has otherwise not been found outside of the Philippines. Considering all these points, we are

deleting it from the Nepal fauna, as advised by Harrison et al. (1991).

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