Immature Stages of Mosquitoes (Diptera: Culicidae) Collected During the Autumn-Winter Period in Cordoba Province, Argentina

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Eggs, immature mosquito collections were made at Cosquin, La Calera (Chaco phytogeographic region), Villa Allende and Villa del Rosario (Espinal phytogeographic region) during April/September of two consecutive years 1989, 1990. Specific immature habitats in each locality were identified and sampled monthly. Eggs and/or immatures of Aedes albifasciatus, Ae. fluviatilis, Anopheles albitarsis, Culex acharistus, Cx. apicinus, Cx. bidens, Cx. coronator, Cx. chidesteri, Cx. dolosus, Cx. maxi, Cx. quinquefasciatus, Cx. saltanensis, Psorophora ciliata *and* Uranotaenia lowii *were collected. Three species (*Cx. acharistus, Cx. dolosus *and* Cx. quinquefasciatus*) were collected during the sampling period for all developmental stages. This suggests that immatures of these species do not overwinter but continue to develop throughout the cold autumn and winter seasons.*

Key words: Culicidae - *Aedes* - *Anopheles* - *Culex* - *Psorophora* -*Uranotaenia* - immature stages - winter biology

In regions where the seasons are well defined and the winter is severe, some species of mosquitoes hibernate in the adult stage (taking refuge in shrubs, tree holes, mines, burrows, caves, man-made wood and rock piles, drains, etc.), while other species undergo diapause in the egg stage or pass the winter in the larval stage (Carpenter & La Casse 1955, Harwood 1962, Bellamy & Reeves 1963, Ishii et al. 1964, Shemanchuk 1965, Anderson & Harwood 1966, Mitchell 1988). In warmer climates, immature and adult development slows during the cooler seasons. However, population growth may be decreased more as a result of habitat reduction rather than temperatures.

Few studies have been conducted on the winter biology of mosquitoes in Argentina. Prosen et al. (1960) found a few adults of *Culex quinquefasciatus* during the winter season in Buenos Aires Province, but no more details are provided. Almiron (1993) concluded that *Cx. quinquefasciatus* immatures continue to develop during the cold seasons of the continental temperate climate of Cordoba Province. The discovery of eggs, larvae and pupae of mosquitoes in natural field environments during the autumn-winter period suggests that immatures continue to develop throughout these seasons. This study, is the first contribution to our knowledge of the winter biology and development of immature mosquitoes in Cordoba Province.

MATERIALS AND METHODS

Study site - Cordoba is a mediterranean province (29°29'-35°1'LS, 32°54'-61°46'LW) with different phytogeographic regions. The Chaco phytogeographic region is divided into the western and eastern woodlands. Cosquin and La Calera are situated in the eastern woodland and show the greatest development and physiognomical variety in the province. The annual precipitation is between 550-600 mm. The Espinal phytogeographic region is mixed grassland and woodland, similar to impoverished Chaco, with about 800 mm of annual precipitation (Luti 1979). Cordoba Province has a temperate climate, mesothermal and low rainfall (380-900 mm). Its principal rainy season is March, and its secondary one is during October through December. Freezing temperatures are recorded from April through September, July being the month with the most days (6.5 days) of frost. The mean temperature is between 17°C in the SE and 20°C in the NE (Capitanelli 1979).

Collections - Eggs and immature mosquito populations were sampled in Cosquin -31°1'LS, 64°4'LW-, La Calera -31°2'LS, 64°3'LW- (Chaco phytogeographic region), Villa Allende -31°2'LS, 64°3'LW- and Villa del Rosario -31°5'LS, 63°5'LW- (Espinal phytogeographic region) during April through September 1989 and 1990. Specific immature habitats at each locality were

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sampled monthly. Of these, ten were located in Cosquin, six in La Calera, seven in Villa Allende and nine in Villa del Rosario. Immature habitats, i.e., ground pools, swamps, drains, a pond, and two metalic containers were sampled. Also, on several occasions immatures were taken from rivers and stream margins. Samples were conducted by dipping 20 times/immature habitat with 300 ml dippers.

Identification - Eggs, immatures and adults were identified using species descriptions and keys by Lane (1953), Forattini (1962, 1965 a,b) and Darsie (1985). The collected specimens were deposited in the mosquito collection of Centro de Investigaciones Entomologicas de Cordoba, Facultad de Ciencias Exactas, Fisicas y Naturales, Universidad Nacional de Cordoba.

RESULTS

Fourteen species of immature mosquitoes belonging to the genera *Aedes, Anopheles, Culex, Psorophora* and *Uranotaenia* were collected. *Ae. albifasciatus, Cx. acharistus, Cx. dolosus* and *Cx. quinquefasciatus* were the most abundant species (Table). Species were divided into three groups (A, B and C) according to the frequency that immature stages were collected. *Cx. acharistus, Cx. dolosus* and *Cx. quinquefasciatus* were collected during April through September in the same locality: *Cx. acharistus* in Cosquin (1990), *Cx. dolosus* in Cosquin, Villa Allende (1989), Cosquin and Villa del Rosario (1990), and *Cx. quinquefasciatus* in Villa del Rosario (1990) (Group A). *Ae. albifasciatus, An. albitarsis, Cx. apicinus* and *Cx. maxi* were collected during 2-3 months of the sampling period in the same locality (Group B). Other species were found only on one occasion for each locality during each year (Group C).

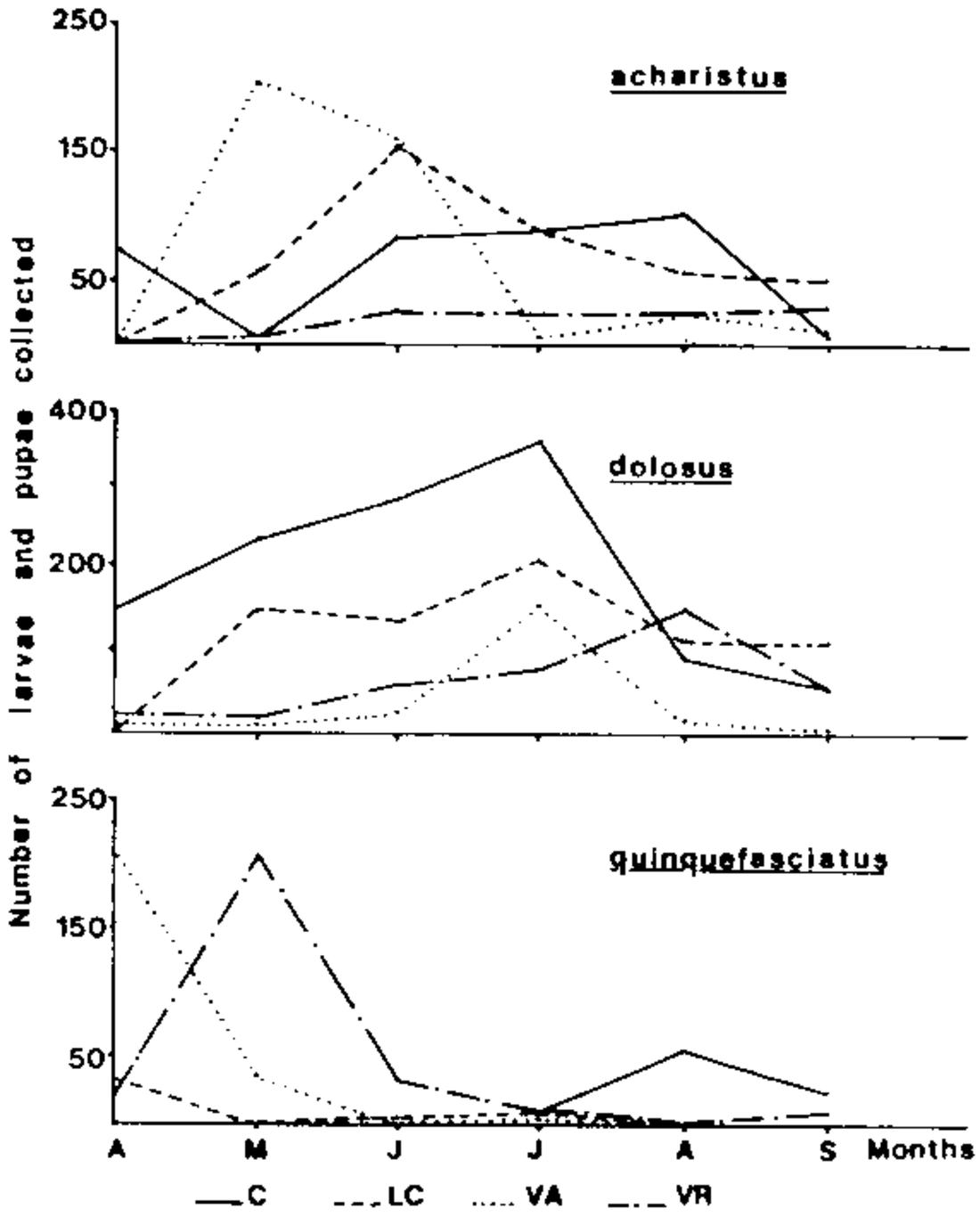
Eggs, larvae and pupae of *Cx. acharistus, Cx. dolosus* and *Cx. quinquefasciatus* were collected both in autumn and winter and in both phytogeographic regions. *Cx. acharistus* and *Cx. dolosus* were collected at each study site for both years. Different larval instars were collected during the same collection period throughout the study localities. This was observed more frequently for *Cx. dolosus*. *Cx. acharistus* was collected more frequently in May 1989 and May-June 1990 (Fig.). *Cx. dolosus* was more abundant during late autumn and winter in July 1989 and between May-August 1990 (Fig.). *Cx. quinquefasciatus* was abundant both in autumn and winter, being collected more frequently between April/June 1989 and May/August 1990 (Fig.).

Aedes albifasciatus, An. albitarsis, Cx. apicinus and *Cx. maxi* were collected as larvae and/or pupae. They were collected during both sampling periods, except *An. albitarsis* which was collected

TABLE

Number of larvae and pupae collected during April/September 1989, 1990 at Cosquin (C), La Calera (LC), Villa Allende (VA) and Villa del Rosario (VR), Cordoba Province, Argentina

Species	C		L C		V A		V R		Total
	1989	1990	1989	1990	1989	1990	1989	1990	
Aedes									
albifasciatus	20	-	-	-	-	3	-	1157	1180
fluviatilis	-	45	-	-	-	-	-	-	45
Anopheles									
albitarsis	-	-	-	-	-	-	-	5	5
Culex									
acharistus	164	195	305	111	30	389	9	102	1305
apicinus	-	56	-	-	57	1	5	7	126
bidens	5	-	2	-	-	3	42	-	52
coronator	-	1	-	-	-	-	-	-	1
chidesteri	3	-	1	-	-	-	-	-	4
dolosus	160	1013	451	242	122	105	128	256	2477
maxi	5	-	2	-	-	-	32	7	46
quinquefasciatus	-	90	52	-	52	201	265	15	675
saltanensis	12	-	-	-	1	1	-	11	25
Psorophora									
ciliata	-	-	-	-	-	-	-	1	1
Uranotaenia									
lowii	-	-	-	-	-	-	-	25	25
Total									5967



Number of larvae and pupae of *Culex acharistus*, *Cx. dolosus* and *Cx. quinquefasciatus* collected during April/September 1989, 1990 at Cosquin (C), La Calera (LC), Villa Allende (VA) and Villa del Rosario (VR), Cordoba Province, Argentina.

only in 1990. *An. albitarsis* appeared only in the Espinal phytogeographic region, while the other species were collected in both regions.

Larvae of *Ae. fluviatilis* and *Cx. coronator* were collected in Cosquin while larvae of *Ps. ciliata* and *Ur. lowii* were collected in Villa del Rosario. *Cx. bidens* was collected in all sampling localities as eggs and/or larvae; it was only found during three months of the sampling period. Pupae of *Cx. chidesteri* were collected in Cosquin and La Calera in August 1989. *Cx. saltanensis* was collected in Cosquin, Villa Allende and Villa del Rosario as larvae and/or pupae.

Culex bidens and *Cx. saltanensis* were collected during the autumn, in both phytogeographic regions. *Cx. coronator* (autumn), *Ae. fluviatilis* and *Cx. chidesteri* (winter) were collected in the Chaco phytogeographic region, while *Ps. ciliata* and *Ur. lowii* (autumn) were found in the Espinal phytogeographic region.

DISCUSSION

Immature collections of eggs, different larval instars and pupae of *Cx. acharistus, Cx. dolosus* and *Cx. quinquefasciatus* (Group A) throughout the sampling period, suggest that immature development of these species continue during the autumn and winter seasons in Cordoba Province. This is further supported by the high immature populations in the study localities.

Although *Ae. albifasciatus, An. albitarsis, Cx. apicinus* and *Cx. maxi* (Group B) were collected both in autumn and winter, the number of individuals collected, except for *Ae. albifasciatus*, was only 3.15% compared to the total number of individuals of all other species (Groups A, B, C). These results do not provide sufficient information to determine if *An. albitarsis, Cx. apicinus* and *Cx. maxi* continue their development during the autumn-winter period.

Since eggs and immatures of Group C species were infrequently collected, there is insufficient evidence to support that immatures develop during autumn and winter. However, *Ae. fluviatilis* and *Cx. chidesteri* were collected during winter, suggesting that development and emergence occurred.

Almiron (1993) found that *Cx. quinquefasciatus* females kept under experimental conditions blood-fed and oviposited even during the autumn-winter period, in Cordoba Province. In addition, he demostrated that eggs hatched and the immature stages developed during the cold seasons. Hayes (1975) and Hayes and Hsi (1975) reported year-round egg production for an isolated *Cx. quinquefasciatus* population in Houston, Texas, during a 2.5-year period. The continuous reproduction and immature development occurred despite low winter temperatures and snowfall. Eggs of this species were collected in the field both in autumn and winter during this study, suggesting that adult blood-feeding and oviposition occurred during this period.

According to Mitchell (1988), eggs of all aedine mosquitoes become quiescent if conditions are unfavorable for hatching. The immature habitats (Villa del Rosario) where *Ae. albifasciatus* larvae (Group B) were collected in July 1990, and were dryed during the previous month. Despite the low temperature and short photoperiod, eggs would have only hatched after the rains and flooding. Larvae of this species were collected from January to May and from August to December in Mar Chiquita Lagoon, Cordoba Province (Jimenez & Sedran 1991), i.e., also in autumn and winter. According to Prosen et al. (1960) larvae of this species are frequently found in summer and autumn in Buenos Aires Province. Apart from collecting larvae of *Ae. albifasciatus* in fall (Cosquin, Villa Allende and Villa del Rosario) and winter (Villa del Rosario), adult females were also captured on human hosts during the autumn-winter period in La Calera, Villa Allende and Villa del Rosario. These data indicate that adults are actively

blood-feeding and could oviposit during the cold and dry seasons. Hack et al. (1978) collected specimens of *Ae. albifasciatus* on human hosts in Corrientes Province from April to October and December. Hack's findings indicate that this species predominates in autumn and winter, showing an abundance peak in June. Although climatic features from Corrientes Province (Subtropical) and Cordoba Province (Continental Temperate) are different, *Ae. albifasciatus* is one of the three species that Hack collected at minimum temperatures (8°C). According to these data, this species would continue its activity even during the less favorable period of low temperatures. Based on our results and others findings, i.e., observing larvae and adult females in autumn and winter, it appears likely that this species is homodynamic.

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REFERENCES

Almiron WR 1993. *Bionomia y taxonomia de los principales mosquitos (Diptera, Culicidae) recolectados en Cordoba, con particular enfasis en el genero* Culex *L. 1758*. Thesis (Universidad Nacional de Cordoba), 221 pp.

Anderson AW, Harwood RF 1966. Cold tolerance in adult female *Culex tarsalis* (Coquillett). *Mosq News 26*: 1-7.

Bellamy RE, Reeves WC 1963. The winter biology of *Culex tarsalis* (Diptera, Culicidae) in Kern County, California. *Ann Ent Soc Am 56*: 314-323.

Capitanelli RG 1979. Clima. p.45-138. In JB Vazquez, RA Miatello, ME Roque (eds). *Geografia Fisica de la Provincia de Cordoba*. Boldt Rep. Argentina.

Carpenter SJ, La Casse WJ 1955. *Mosquitoes of North America*. University of California Press, 360 pp.

Darsie RF 1985. Mosquitoes of Argentina. Part I. Keys for identification of adult females and fourth stages larvae in english and spanish (Diptera, Culicidae). *Mosq Syst 17*: 153-253.

Forattini OP 1962. *Entomologia Medica. I. Parte General, Diptera, Anophelini*. Faculdade de Saúde Pública. Depto. Parasitol., São Paulo, Brasil, 622 pp.

Forattini OP 1965a. *Entomologia Medica. II. Culicini: Culex, Aedes, Psorophora*. Universidade de São Paulo, Brasil, 506 pp.

Forattini OP 1965b. *Entomologia Medica. III. Culicini: Haemagogus, Mansonia, Culiseta. Sabethini. Toxorhynchitini. Arboviruses. Filariose bancroftiana. Genética*. Universidade de São Paulo, Brasil, 416 pp.

Hack WH, Torales GJ, Bar NE, Oscherov B 1978. Observaciones etológicas sobre culícidos de Corrientes. *Rev Soc Entomol Arg 37*: 137-151.

Harwood RF 1962. Trapping overwintering adults of the mosquitoes *Culex tarsalis* and *Anopheles freeborni*. *Mosq News 22*: 26-31.

Hayes J 1975. Seasonal changes in population structure of *Culex pipiens quinquefasciatus* Say (Diptera, Culicidae): study of an isolated population. *J Med Entomol 12*: 167-178.

Hayes J, Hsi BP 1975. Interrelationships between selected meteorologic phenomena and immature stages of *Culex pipiens quinquefasciatus* Say: study of an isolated population. *J Med Entomol 12*: 299-308.

Ishii T, Magai A, Hirono T, Nakamura K 1964. Hibernation of mosquitoes in rock caves on Miyato Island. *Sci Rep Tohoku Univ Ser 30*: 159-165.

Jimenez AL, Sedran JC 1991. Sitios de cria de *Aedes albifasciatus* Maq. (Diptera, Culicidae) en el ecosistema de la laguna Mar Chiquita, Provincia de Cordoba, Argentina. II Congreso Argentino de Entomologia. La Cumbre, Cordoba, Argentina, 219 pp.

Lane J 1953. *Neotropical Culicidae*. Ind. Graf. Siqueira S. A. São Paulo, Brasil, 1112 pp.

Luti R 1979. Vegetacion. p.297-368. In JB Vazquez, RA Miatello, ME Roque (eds). *Geografia Fisica de la Provincia de Cordoba*. Boldt Rep. Argentina.

Mitchell JC 1988. Occurrence, biology and physiology of diapause in overwintering mosquitoes. p.191-217. In TP Monath. *The Arboviruses: Epidemiology and Ecology*. Vol. I. CRC Press, Inc, Boca Raton, Florida.

Prosen AF, Martinez A, Carcavallo RV 1960. La familia Culicidae (Diptera) de la rivera fluvial de la provincia de Buenos Aires. *An Inst Med Reg* (Universidad Nacional del Noreste, Corrientes, Argentina) *5*: 101-113.

Shemanchuck JA 1965. On the hibernation of *Culex tarsalis* Coquillett, *Culiseta inornata* Willinston and *Anopheles earlei* Vargas (Diptera, Culicidae) in Alberta. *Mosq News 25*: 456-462.