

SEASONAL PREVALENCE OF *CULEX VISHNUI* SUBGROUP, THE MAJOR VECTORS OF JAPANESE ENCEPHALITIS VIRUS IN AN ENDEMIC DISTRICT OF ANDHRA PRADESH, INDIA

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ABSTRACT. Seasonal prevalence of members of the *Culex vishnui* subgroup, the major vectors of Japanese encephalitis virus (JE) in an endemic district of Andhra Pradesh, was investigated. Approximately 15,500 mosquitoes belonging to 2 genera and 5 species were collected by indoor-resting collections. The predominant species were found to be from the *Cx. vishnui* subgroup, which comprised 42.6% of the total collection, followed by *Anopheles subpictus* (40.4%), *An. hyrcanus* (12.8%), *Cx. gelidus* (3.5%), and *An. barbirostris* (0.8%). Mosquitoes of the *Cx. vishnui* subgroup were collected throughout the year, and densities of females ranged from 2.3/man-hour in January 1999 to 26.0/man-hour in December 1999. Ninety-three cases of Japanese encephalitis (27 confirmed serologically) were reported, mainly during the monsoon months of November and December. A significant positive correlation between densities of mosquitoes of the *Cx. vishnui* subgroup and occurrence of Japanese encephalitis cases ($r = 0.765$, $P < 0.01$) was observed. The factors responsible for transmission of JE in the endemic district are discussed.

KEY WORDS Japanese encephalitis, *Culex vishnui* subgroup, Andhra Pradesh, India

INTRODUCTION

Japanese encephalitis was 1st recognized in Japan and is prevalent in many Southeast Asian countries. In the last 3 decades, Japanese encephalitis virus (JE) has been responsible for major outbreaks of the disease in India. In India, JE was 1st recognized in 1955 from cases of encephalitis admitted to the Christian Medical College and Hospital, Vellore (Tamil Nadu). The virus was isolated from wild-caught mosquitoes in the same area and isolation from brain tissue of human cases followed in 1958 (Reuben and Gajanana 1997).

Serological surveys carried out between 1955 and 1972 showed that JE infections occurred in scattered areas in Gujarat, Maharashtra, Orissa, Assam and Arunachal Pradesh, with the highest prevalence in the 3 southern states of Tamil Nadu, Andhra Pradesh, and Karnataka. Small numbers of human cases were reported only in southern India. The 1st major outbreak of Japanese encephalitis, involving more than 700 cases and 300 deaths, occurred in Burdwan and Bankura districts of West Bengal in 1973 followed by a 2nd outbreak in 1976 (Banerjee 1996). Between 1977 and 1979, extensive outbreaks involved new areas, including Tirunelveli District in Tamil Nadu, Kolar District in Karnataka, several districts in West Bengal and Andhra Pradesh, Dhanbad District in Bihar, Dibrugarh District in Assam, and Gorakhpur District in Uttar Pradesh (Reuben and Gajanana 1997).

Since then, these areas have become prone to outbreaks of Japanese encephalitis, with large num-

bers of cases occurring each year. Outbreaks frequently coincide with years having heavy or unusual rainfall patterns. New areas recently have been involved in transmission of JE, including Cuddalore (formerly South Arcot District) and Tiruchirappalli districts in Tamil Nadu, the Union Territories of Pondicherry, Goa, and most recently in Haryana and Kerala (Samuel et al. 2000).

In nature, JE is maintained by a complex cycle that involves pigs as amplifying hosts, ardeid birds as reservoirs, and mosquitoes as vectors. Members of the *Culex vishnui* subgroup of mosquitoes have been recognized for many years as major vectors and they play an important role in the epidemiology of JE in India (Samuel et al. 2000). The *Cx. vishnui* subgroup includes *Culex tritaeniorhynchus* Giles, *Cx. vishnui* Theobald, and *Cx. pseudovishnui* Colless. These species are extremely common, widespread, and breed mainly in paddy fields. Their abundance often is related to rice cultivation. Blood meal analysis showed that these mosquitoes were principally cattle-feeders, although human- and pig-feeding was also recorded in villages near Madurai and in Nallur Primary Health Center of Cuddalore District (Reuben et al. 1992).

Japanese encephalitis control programs face serious problems because of the nonavailability of suitable cost-effective control strategies. Vaccination and vector control are the only 2 available tools for the containment of the disease. Because of the limited availability of JE vaccine, it is not possible to vaccinate all the persons who are at risk of JE infection in endemic states. Hence, vector control is the only option available for disease control. Study of the seasonal abundance of vector populations it is absolutely essential to develop suitable vector control strategies.

MATERIALS AND METHODS

In Andhra Pradesh, incidence of Japanese encephalitis has been recorded almost every year in

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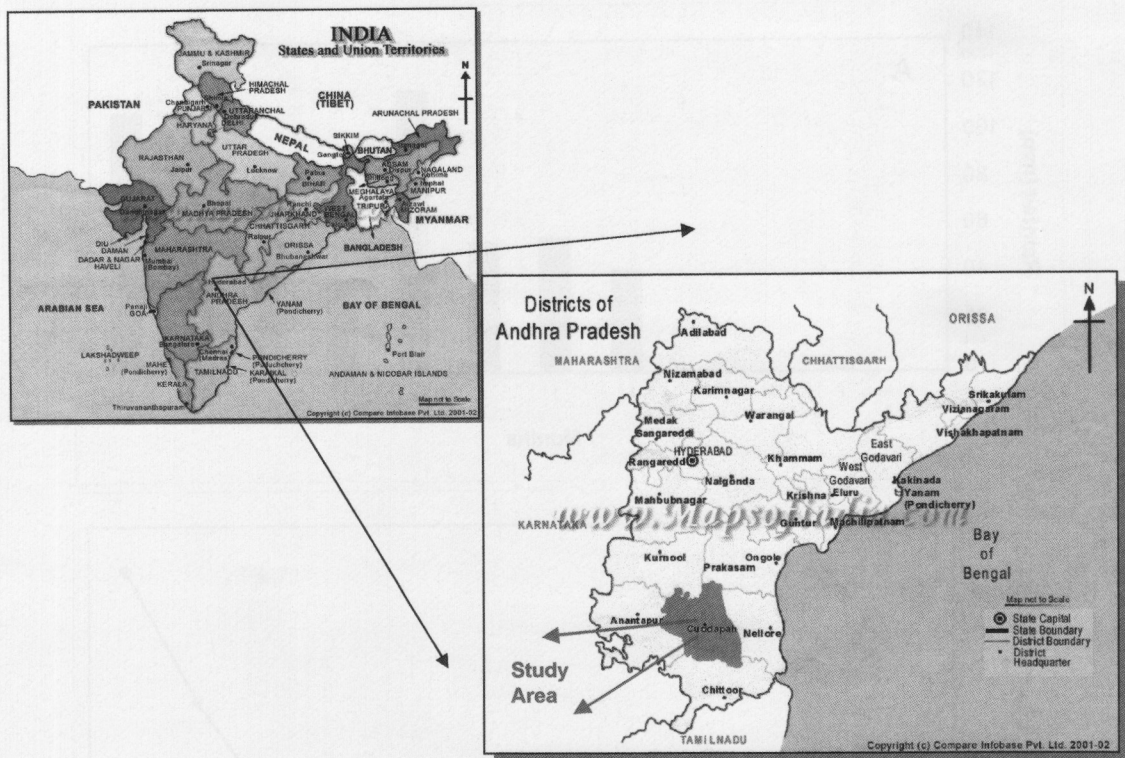


Fig. 1. Map showing the study area. Reprinted by permission of Compare InfoBase Pvt. Ltd., 2002.

the districts of Kurnool, Anantapur, Guntur, Krishna, Prakasam, Nellore, Nalgonda Warangal, Cuddapah, and Chittoor. Among these districts, villages from Cuddapah District were selected for longitudinal studies of the adult population of the *Cx. vishnui* subgroup (Fig. 1). Seasonal patterns of these mosquitoes were followed to develop an early warning system to initiate control measures.

Cuddapah District has a number of rivers. However, all flow in rainy seasons and remain dry in the remaining part of the year. The Pennar River and its tributaries are the important rivers of the district. The annual total rainfall of the district in the study year was 569.7 mm. Highest rainfall was recorded (>90 mm) in the months of August, October, and November (Fig. 2A).

Mosquito collections were made by hand aspirator in and around cattle sheds and indoor dwellings in fixed villages. Mosquito collections began at 0800 h and continued for exactly 1 h. This method is extremely simple, provides a stable index comparable to other methods of collection, and is repeatable. All the collections were brought to the laboratory in Hyderabad for identification. The density per man-hour was calculated as number of female mosquitoes collected per man-hour. Mosquitoes were identified with the keys of Reuben et al. (1994).

RESULTS AND DISCUSSION

A total of 15,512 mosquitoes belonging to 2 genera and 5 species was collected. Species belonging to the *Cx. vishnui* subgroup dominated the collections, comprising 42.6% of the total collections. Other species collected were *Anopheles subpictus* (Grass) (40.4%), *An. hyrcanus* (Pallas) (12.8%), *Culex gelidus* Theobald (3.5%), and *Anopheles barbirostris* Van der Wulp (0.8%). Mosquitoes of the *Cx. vishnui* subgroup were present in all months and the abundance (females per man-hour) of mosquitoes ranged from 2.3 in January 1999 to 26.0 in December 1999 (Fig. 2B). The villages in Cuddapah District have very favorable conditions for breeding of JE vectors during postmonsoon months. Irrigation channels, shallow ditches, pools, and paddy fields contributed significantly to populations of mosquitoes of the *Cx. vishnui* subgroup. An increase in vector abundance in monsoon months may have led to transmission of JE. The close proximity of houses of villagers to animal sheds may be an additional factor that increased exposure of the human population to vector mosquitoes.

A similar behavior was observed in Vellore District, where members of the *Cx. vishnui* subgroup predominated during the Northeast monsoon (Reu-

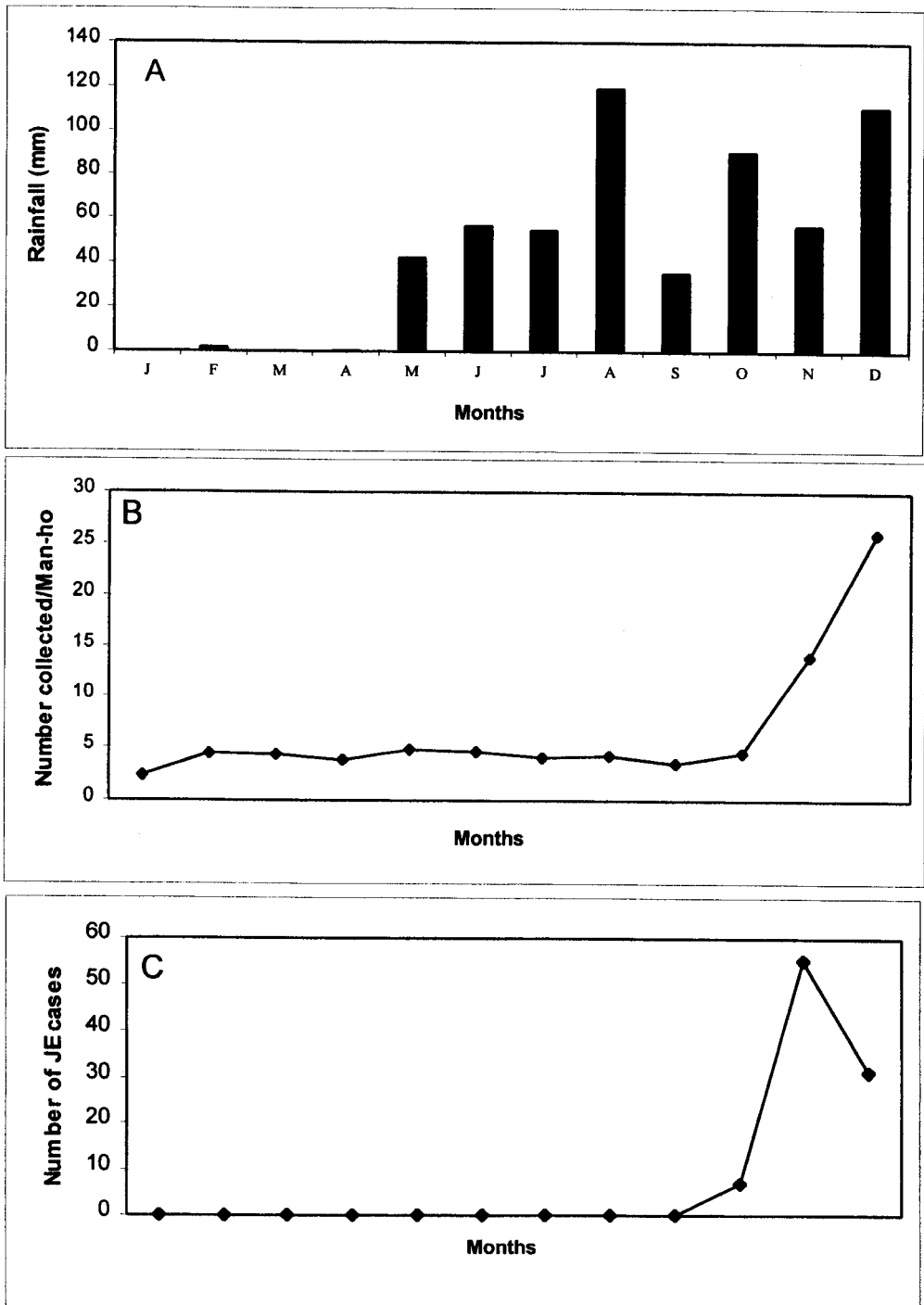


Fig. 2. (A) Rainfall, (B) abundance of female mosquitoes of the *Culex vishnui* subgroup, and (C) occurrence of Japanese encephalitis virus (JE) cases in Cuddapah District during 1999.

ben 1971). A similar increase in the abundance of members of the *Cx. vishnui* subgroup was noticed during the monsoon season in Sarawak (Hill 1970). Because rainfall dominates all agriculture practices,

therefore, rainfall also was thought to influence mosquitoes of the *Cx. vishnui* subgroup, which breed mainly in rice fields. In Cuddalore District, a similar trend in abundance of mosquitoes of the *Cx.*

vishnui subgroup was observed coinciding with the beginning of rains and rice cultivation (Gajanana et al. 1997). Population densities of members of the *Cx. vishnui* subgroup in Andhra Pradesh follow the rainfall pattern, being least abundant in hot dry season and most abundant during and after the North-east monsoon.

Sixty-eight villages were affected by encephalitis in 1999 and 93 cases were reported from these villages. These data were collected from the Directorate of Health Services, Hyderabad. Out of these 93 cases, 27 cases were associated serologically with JE and these cases were reported mainly during October to December (Fig. 2C). The correlation coefficient of abundance of members of the *Cx. vishnui* subgroup and occurrence of Japanese encephalitis cases was calculated and a significant positive correlation was noticed between densities of mosquitoes of the *Cx. vishnui* subgroup and occurrence of Japanese encephalitis cases ($r = 0.765$, $P < 0.01$). In southern India, studies on seroconversion in school children showed that seroconversion occurred between July and September and that more than 70% of the cohort had seroconverted by October (Gajanana et al. 1995). The same also may be true for Andhra Pradesh because of the similar ecological conditions, the presence of large numbers of pigs, and the higher abundance of mosquitoes of the *Cx. vishnui* subgroup.

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