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FIRST RECORD OF *OCHLEROTATUS (FINLAYA) JAPONICUS JAPONICUS* (THEOBALD, 1901) IN METROPOLITAN FRANCE

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ABSTRACT. *Ochlerotatus (Finlaya) japonicus japonicus* is a potential vector of arboviruses such as Japanese encephalitis virus and West Nile virus. The latter already is present in France. We report the species for the 1st time in metropolitan France and in Europe. Two larvae were collected in July and October 2000 in used tires in a village in northwestern France. Collections were made in a stack of recycled tires from a company that imports from the USA and Japan. The lack of other routes of introduction for the species confirms tires as a means of worldwide spread. Larval stages found in the area indicate that the species is reproducing locally.

KEY WORDS Diptera, Culicidae, *Ochlerotatus japonicus japonicus,* larvae, used tires, France

INTRODUCTION

Ochlerotatus japonicus sensu lato includes 4 subspecies distributed as follows (Tanaka et al. 1979): *Oc. (Fin.) japonicus amamiensis* (Tanaka et al., 1979) (Ryu Kyu Archipelago: Amami Guntô Island), *Oc. (Fin.) japonicus japonicus* (Theobald, 1901) (Palearctic Japan, Korea: Korean Peninsula, and Cheju Do, Russia: south of the Maritime Province [Gutsevich and Dubitskiy 1987]), *Oc. (Fin.) japonicus shintienensis* (Tsai et Lien, 1950) (Taiwan), and *Oc. (Fin.) japonicus yaeyamensis* (Tanaka et al., 1979) (Ryu Kyu Archipelago: Yaeyama Guntô Island). Populations in China (southern region) and Hong Kong probably consist of *Oc. j. shintienensis.*

Outside its original breeding area, *Oc. j. japonicus* was intercepted in New Zealand in January and March 1993 along with *Aedes albopictus* (Skuse, 1894) in used tire containers imported from Japan (Laird et al. 1994) and in buckets in a boat stationed in Port of Auckland in 1998 and 1999 (Fonseca et al. 2001). In the USA, the species was identified from collections made in 1998 in New York and New Jersey (Peyton et al. 1999), but recent field observations suggest that the species may have been introduced several years before it was recognized (Scott et al. 2001). Subsequently, the species was recorded from Connecticut in 1998 and 1999; in Ohio and Pennsylvania in 1999 (Fonseca et al. 2001); and in Maryland, Massachusetts, and Virginia in 2000 (Sardelis and Turell 2001). The species was caught in Quebec, Canada, in 2000 (C. Back, personal communication). The used tire trade (Peyton et al. 1999) is suspected to be the mode of introduction into the USA and the Standardbred horse trade (Fonseca et al. 2001) appears to be the mode of transportation from state to state within the USA.

After the discovery of *Ae. albopictus* in France in the autumn of 1999 (Schaffner and Karch 2000), a surveillance program was implemented in metropolitan France (overseas territories excluded) at the request of the French Ministry of Health (under the responsibility of the Adege, the organization of the main French public mosquito control agencies). This program surveys the major used tire importation storage centers and the 2 sites harboring *Ae. albopictus.* The 1st *Oc. j. japonicus* in France and Europe were found in collections made by the entomologists of the Atlantic coast mosquito-control agency (Scott et al. 1999).

MATERIALS AND METHODS

Ochlerotatus japonicus japonicus was found in a large stock of used tires located in the small village of Montsecret (ED50 coordinates: 48°48′00″N, 0°40′30″W, altitude 145 m) in Orne Department (Basse-Normandie). The company imports tires from many countries, including the USA and Japan. Six visits were made between October 1999 and October 2000. Tires were stacked outside and other nearby potential mosquito breeding sites were checked. Many of the tires were exposed to rainfall and contained water and organic material (dead leaves). Dry ice traps were set.

RESULTS

The 1st specimen of *Oc. j. japonicus* was found in France on July 17, 2000, and was a 2nd-stage larva. It was located in a batch of tires of local origin. A few larvae of *Culex pipiens* Linnaeus, 1758 (form unknown) also were present. The specimen was identified with difficulty as *Oc. j. japonicus* after mounting and examination on a slide. In a subsequent visit on September 21, no other larvae of *Oc. j. japonicus* were found and we were told that the tires containing the 1st larva had been sold.

A 2nd larva (3rd instar) was collected on October 12, 2000, in another batch of local tires stacked on the opposite side of the storage area. It was associated with *Culex hortensis hortensis* Ficalbi, 1889, *Cx. pipiens, Anopheles plumbeus* Stephens, 1828, and *Culiseta annulata* (Schrank, 1776). Four dry ice traps were set during the night,

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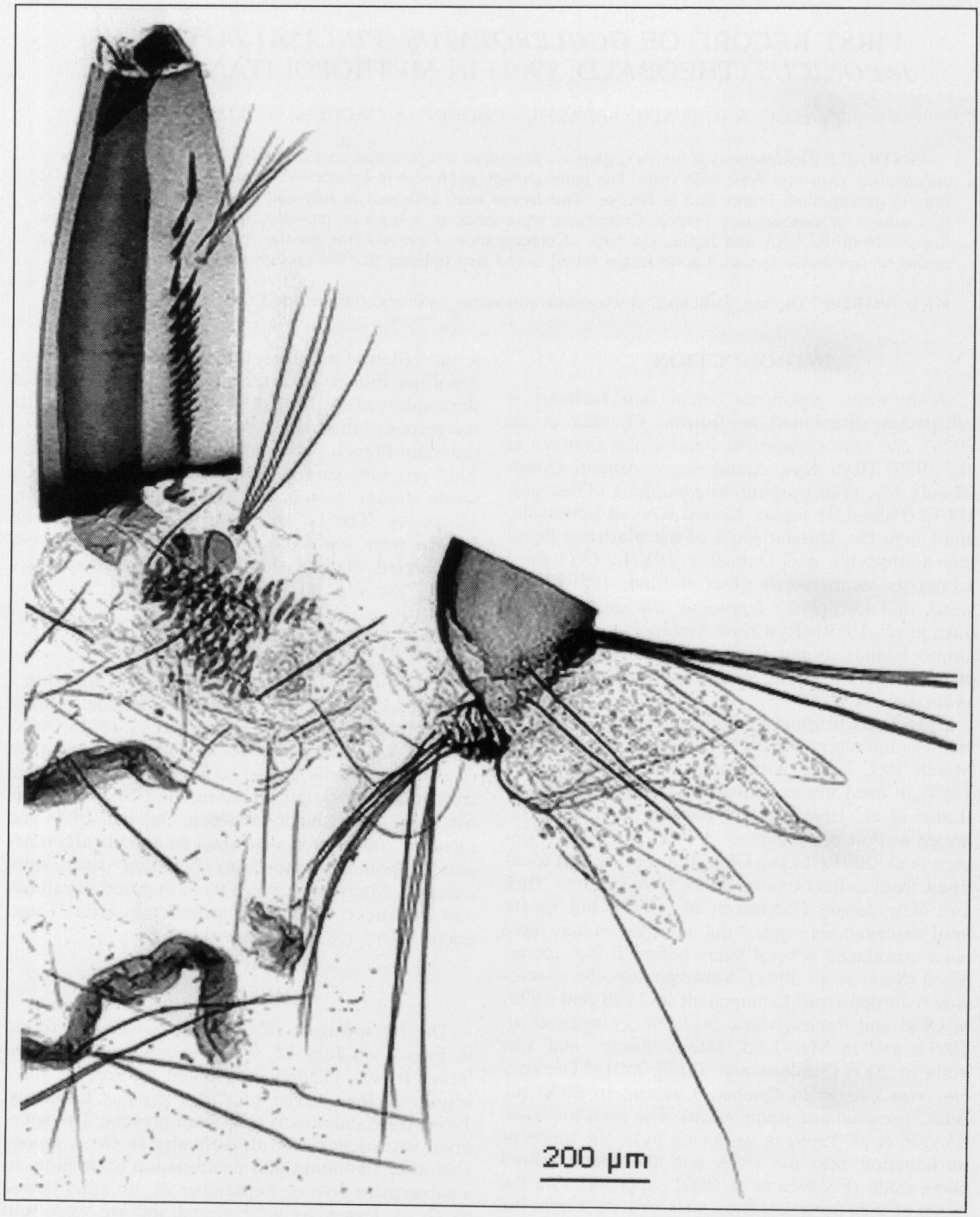

Fig. 1. Characters used in identification of 4th-stage larva. Pecten have 4 detached, enlarged and smooth teeth; comb scales were broadly paddle shaped, with strong apical and subapical spicules.

but only 1 female of *Cx. pipiens* was caught. The larval *Ochlerotatus* was identified on site and reared in the laboratory to adult stage under ambient light and temperature conditions. A male emerged on November 7th, and identification was confirmed. The larval and pupal exuviae and the male hypopygium were mounted on slides. The male was pinned and all specimens were photographed. Other mosquito species collected in the tires were *Anopheles claviger* s.s. (Meigen, 1804),

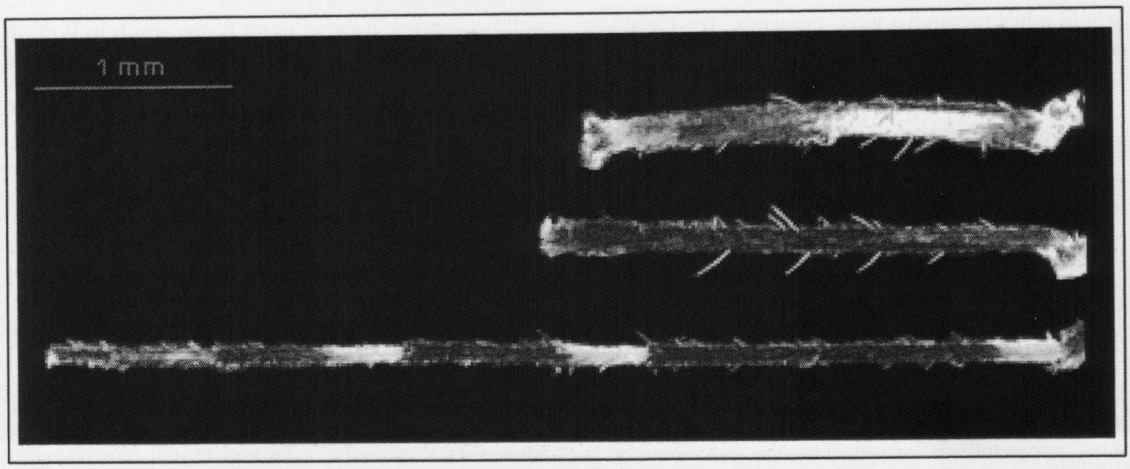

Fig. 2. Hindleg characters of the adult male. Note the dark subbasal distinct bands and complete bands on the anterior area of hind femora and that the 1st 3 tarsal segments of hindleg are basally banded. The 4th tarsal segment is not banded.

Ochlerotatus geniculatus (Olivier, 1791), *Ae. albopictus, Cx. h. hortensis,* and *Cx. pipiens. Culex* species were the most abundant of all (80% of the collected immature stages).

Identification was made on the basis of the drawings and description of Tanaka et al. (1979). Larvae were identified by using the characters illustrated in Fig. 1. The adult male was identified by using the characters illustrated in Fig. 2 and the subspiracular area was naked. The subspecific characters followed those of Tanaka et al. (1979). Characters on the hypopygium appear in Fig. 3. Drawings of the

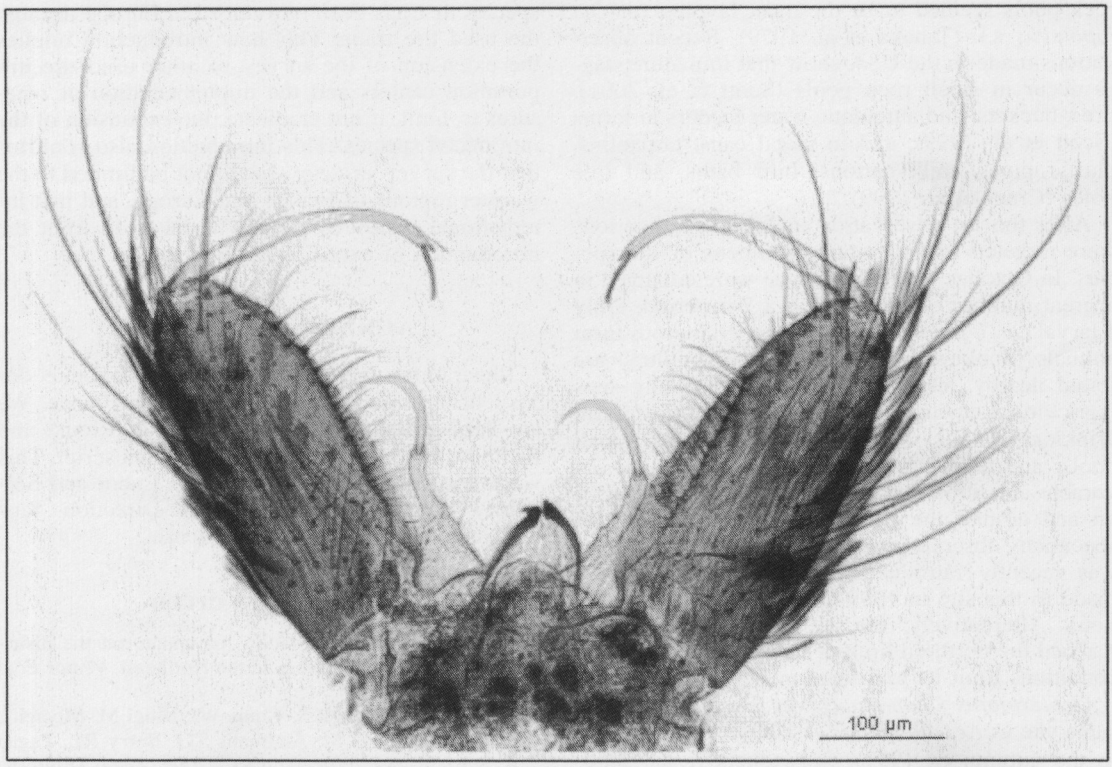

Fig. 3. Hypopygium characters of the adult male. The basal and apical lobes of the hypopygium are indistinct, the claspette stem is pubescent, and the filament is simple and arcuate.

whole adult mosquito were presented by Tanaka et al. (1979) and Peyton et al. (1999).

DISCUSSION

Our observation of *Oc. j. japonicus* is the 1st made in France and in Europe. It is to date the northernmost world record for the species. The storage center is located in an agricultural area, and is distant from other international modes of transport such as aircraft (225 km) or boats (100 km). The occurrence of the species on this site confirms the importance of tires as a means for worldwide transport, and suggests the introduction of eggs in imported used tires. Observation of the larvae in tires of local origin does not give information on their geographical origin, but the presence in 2 batches, distant in space and time, indicates that reproduction takes place in France.

Ochlerotatus japonicus s.l. is likely to bite humans in forests (Kamimura 1968 *in* Peyton et al. 1999) and, occasionally, inside houses (Miyagi 1971). In the laboratory, *Oc. j. japonicus* feeds on chicks and mice but not on reptiles and amphibians (Miyagi 1972). *Ochlerotatus j. japonicus* overwinters as eggs in northeastern Japan and as larvae in southwestern Japan (including Tokyo, at 37°N) (Kamimura 1976 *in* Tanaka et al. 1979). Within their native range, the breeding sites include a wide range of natural and artificial container habitats, but rock pools seemed to be the most favored for *Oc. japonicus* s.l. (Tanaka et al. 1979). Recent observations made in the USA show that immature stages occur in small rock pools (Scott et al. 2001), tires, buckets, and automatic water feeders in farms (Scott et al. 1999), and in metal cans, tarpaulins, plastic pipes, milk cartons, bird baths, and tree holes (Crans et al. 1999).

After the 1st observation in July, investigations were targeted to find other specimens of the species. In October, Culicidae larvae were collected in a great number of tires during a 7-h period. Only 1 larval *Oc. j. japonicus* was found. Numerous farm animals (donkeys, sheep, cattle, and poultry) are found nearby, along with potential breeding sites (agricultural ensilages covered with used tires, farm drinking troughs, barrels, washing places, small pools, and a few tree holes). Considering the favorable conditions for the extension of the species on and around the site, the very low number of specimens observed could indicate that the species was recently introduced (3 previous visits were made to this site in 1999 and 2000 without detection). Alternatively, the subspecies possibly has reached the northern limit of its range, and climatic conditions limit its proliferation.

Ochlerotatus j. japonicus was discovered on the same site as *Ae. albopictus* (1st observed in France in the autumn of 1999). Subsequently, *Ae. albopictus* was found breeding in large numbers and later in the season was found at a 2nd site of the same company, located more to the south in Poitou-Charente (Schaffner et al. 2001). Considering the milder climatic conditions and the greater number of resting sites, we fear that the introduction of *Oc. j. japonicus* there could be more successful. Moreover, *Oc. j. japonicus* is less specialized in its breeding sites and therefore could disperse quickly and become irreversibly established at such a site. Fortunately, no other specimens of these 2 exotic species were discovered at the 15 most important French imported used tire storage centers during the 2000 survey. Surveillance will be continued at the site to determine if the species overwinters in France.

Ochlerotatus j. japonicus is not considered to be an important disease vector in Japan and Korea, but laboratory studies have shown that it can transmit Japanese encephalitis virus both horizontally to mice and vertically to its offspring (Takashima and Rosen 1989). Two American strains (New Jersey and Maryland) also were efficient laboratory vectors of West Nile virus (Sardelis and Turell 2001, Turell et al. 2001). Moreover, West Nile virus was detected in specimens captured in the field in New York (Sardelis and Turell 2001), New Jersey, and Pennsylvania.

Ochlerotatus j. japonicus is the 2nd exotic species discovered in only 2 years of surveillance in France. After *Ae. albopictus* and *Ochlerotatus atropalpus* (Coquillett) (Romi et al. 1999), it is the 3rd species that has been introduced in Europe through the used tire trade. This new introduction implies the extension of the survey to other used tire importation centers and the implementation of measures to limit, if not eradicate, the expansion of the introduced species. This introduction also confirms that the survey strategy should not be limited to the warmer regions of France and Europe, and that international measures should be taken to limit the introduction of exotic mosquito species.

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