**Abstract**

**Background:** Malaria is a former endemic problem in the Camargue, South East France, an area from where very few recent data concerning *Anopheles* are available. A study was undertaken in 2005 to establish potential malaria vector biology and dynamics and evaluate the risk of malaria re-emergence.

**Methods:** Mosquitoes were collected in two study areas, from March to October 2005, one week every two weeks, using light traps+CO₂, horse bait traps, human bait catch, and by collecting females in resting sites.

**Results:** *Anopheles hyrcanus* was the most abundant *Anopheles* species. *Anopheles melanoon* was less abundant, and *Anopheles atroparvus* and *Anopheles algeriensis* were rare. *Anopheles hyrcanus* and *An. melanoon* were present in summer, whereas *An. atroparvus* was present in autumn and winter. A large number of *An. hyrcanus* females was collected on humans, whereas almost exclusively animals attracted *An. melanoon*. Based on an enzyme-linked immunosorbent assay, almost 90% of *An. melanoon* blood meals analysed had been taken on horse or bovine. *Anopheles hyrcanus* and *An. melanoon* parity rates showed huge variations according to the date and the trapping method.

**Conclusion:** *Anopheles hyrcanus* seems to be the only *Culicidae* likely to play a role in malaria transmission in the Camargue, as it is abundant and anthropophilic.
malaria situation needs to be re-examined in Europe [1-5].

In metropolitan France, malaria was endemic until the beginning of the 20th century in marshy areas such as the Landes, the Dombes, Brittany, Alsace, the Rhone delta, Roussillon and Corsica [6]. Then, it decreased drastically due to the drying of marshes, growth of livestock, improvement of housing and life conditions and the use of quinine. The last outbreak was observed in Corsica from 1966 to 1972, with about 30 Plasmodium vivax cases [7,8]. Malaria disappeared from the Camargue after World War II [9].

Nowadays, all the malaria cases reported in France are only imported cases [10], excepted for three suspected, not-confirmed, autochthonous cases in 2006 [11](Doudier, unpublished data). In 2004, the total number of imported cases was 6,109 with a predominance of Plasmodium falciparum [12]. Between 1977 and 2000, 28 airport malaria cases following infected mosquito importation were recorded [13] and very few cases have been notified as congenital malaria or accidental blood exposure [10].

Thirteen Anopheles species have been reported in metropolitan France [14]. Among them, two species were considered to be primary vectors because of their abundance and their potential anthropophily: Anopheles atroparvus in continental France and Anopheles labranchiae in Corsica.

Despite drying of some marshes and consecutive reducing of mosquito populations during the 20th century, Anopheles mosquitoes are still present in France and could be very abundant in some places generating an “anophelism without malaria” situation. However, global and local changes may modify Anopheles biological parameters linked to malaria transmission (vector density, contact between humans and vectors, longevity, species). Only few data on anopheline potential vectors have been collected in France since the seventies [15].

An in-depth longitudinal survey was conducted in the Camargue, to assess vector species and distribution and evaluate mosquito vectorial capacity related to human malaria transmission risk. Dynamics, feeding preferences, parity rates and nightly activity were studied for different Anopheles species.

Methods

Study area

The study was carried out in the Camargue, a large wet area in the South East of France (Figure 1). The main part of the Camargue is located inside the Rhone river delta and it also includes small belts at the east and west sides of the delta. This area has a Mediterranean climate characterized by warm, dry summers and mild, wet winters. Total annual rainfall usually ranges between 500 and 700 mm, with a maximum during October. The annual mean temperature is 14°C. Mean daily minimum and maximum temperatures range from 0°C to 10°C in winter and from 15°C to 30°C in summer (data from “Météo France”).

Water pools and marshes cover a large part of its surface. Water is provided either by rains or by a very tight canal network diverted from the Rhone River and used to irrigate paddies or to fill marshes. Management of water is realized individually by field owners depending on use: grazing for horses, cows or sheep, exploitation of reeds or rice and hunting reserves for waterfowl.

As this area is near the sea, it is characterized by a low deep water table presenting a high salinity. Salinity of breeding site water depends on location and artificial or natural submersion frequency. Marsh flora is very dependant on salinity and xerophily. Different vegetation patches are observed in relation to different biotopes and constitute different types of marshes. Moreover, there are various forms of agriculture (including vineyard, paddies, market gardening, fruit growing) and the cultivation of rice is particularly developed and covers more than 18,000 hectares in the Camargue. Livestock includes horses, cows and sheep.

Two study areas were chosen in the Camargue. They are about 45 kilometres apart. The first one, named “Marais du Vigueirat” (4°46'E; 43°30'N) is a natural reserve, where human activity and impact are very limited. Limited visits, reserve maintenance and fauna and flora surveillance are the only human activities. Some horses and cows graze this area. It presents a large variety of biotopes and different types of marshes. The west side is dominated by a large surface of paddy and on its east side by a particular biotope constituted from a resurgence of the water table. Very few people are resident in this area, but a small town named Mas Thibert is located approximately three kilometres away.

The second study area, named “Carbonnière” (4°13'E; 43°35'N), presents the same variety of biotopes and marshes, including paddy. Human presence and activities are more developed: residents, a large number of tourists, camping and hotels, exploitation of wine and reed beds, breeding of horses and cows, and hunting. Moreover, Carbonnière is located in an area of pest control for mosquitoes and in particular against Aedes (Ochlerotatus) caspius.
Mosquito collections

Adult mosquitoes were captured from March to October 2005, one week out of two, in each study area. Specific trapping sessions were conducted until December. The following collection techniques were used:

- Eight CDC-light traps associated with carbon dioxide dry ice were hung in eight locations in each area from 19:00 to 10:00 hours, two consecutive nights, one week in two from March to October. The mean number of mosquitoes collected in each area from eight traps each night was calculated using the results of the two consecutive nights.

- Mosquito activity was recorded by collecting two CDC-light traps+CO₂ every 2 hours from 20:00 to 08:00 once in August and once in September in each area.

- Hourly human bait collection were made on three adults belonging to the research team from 20:00 to 00:00 and from 02:00 to 04:00, once in August and once in September in each area.

- Three horse bait traps were used at Marais du Vigueirat from 20:00 to 08:00 in May, August and September 2005. The net was hung in a horse shelter near a large opening in the wall. Three others horses were present in the shelter.

- Potential adult resting places were explored regularly from March to December 2005: shelters (with or without animals), bird observatory, medieval tower, water pipe and natural shelters. *Anopheles* females were collected using mouth aspirators. Depending on the observed number of *Anopheles*, the totality or only a fraction was captured. Moreover, collection of mosquitoes in vegetation was realised at the beginning of May using a backpack aspirator.

Field processing of mosquitoes

*Anopheles* individuals were removed from the rest of the collected mosquitoes. They were identified using mor-
Anopheles algeriensis was active at the beginning of the night and presented a very marked peak of biting just after the sunset while An. melanoon appeared as active in the second part of the night.

Resting fauna
Number of mosquitoes collected in resting sites is shown in Table 1. Because sampling effort varied along the season, results do not necessarily reflect dynamics. For both study areas, the maximum An. melanoon captured was in August 2005. They were found only in anthropic, dark, calm areas without any signs of draught and with or without animals. They were never captured in vegetation or in natural shelters. During the rest of the season, it was only found in resting sites directly related to animals. Anopheles atroparvus was essentially found in horse shelters.

Feeding preferences
A total of 267 bloodmeals were tested by ELISA. Blood-fed females were captured in resting sites and light traps. Results per species are presented in Table 2.

Parity rates
Parity rates varied during the season for each species and between species. Results are presented in Table 3. During summer period (June, July and September), parity rates were 0.48 (0.41–0.54) and 0.46 (0.27–0.66) for An. hycanuus and An. melanoon respectively at Carbonnière and An. hyrcanus and An. melanoon respectively at Marais du Vigueirat.

Discussion
Anopheles hycanus was the most collected species in both areas and particularly at Marais du Vigueirat where thousands of specimens were captured per night during the peak. Rice fields constitute prolific larval sites for this species and large populations are frequently associated with some rice growing areas as described in Turkey or Greece. Although it was much less abundant than An. hycanuus, An. melanoon was predominant within the Maculipennis complex in the two study areas. Rioux noticed this abundance by the years 1950: An. melanoon was very abundant in the coastal area and paddies constituted its favourite breeding site. Salières confirmed these observations 20 years later. Data presented here show that An. melanoon abundance has not diminished in the Camargue from the years 1950. Anopheles atroparvus was very rare in 2005, although it had been described as the major vector in the past. It was very abundant and present in several environmental patterns of South East France by the 1940's and 1950's, whereas Salières captured it only five times during a 4-year survey 20 years later. Observations reported here confirmed that this species remained very rare.
Table 1: Total number of Anopheles caught in 2005 by methods and months in the Camargue

| Study area       | Capture method | Species          | Mar. | April | May  | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|------------------|----------------|------------------|------|-------|------|------|------|------|-------|------|------|------|-------|
| Carbonnière      | Light trap     | An. melanoon     | 0    | 0     | 10   | 39   | 45   | 122  | 18    | 0    | -    | -    | 234   |
|                  |                | An. atroparvus   | 0    | 0     | 1    | 1    | 1    | 0    | -     | -    | 4    |      |       |
|                  | An. hyrcanus   |                  | 0    | 16    | 673  | 374  | 3,257| 1,228| 3     | 1,228| 3    | -    | 5,551 |
| Resting fauna    | An. melanoon   |                  | 0    | 1     | 3    | 114  | -    | 182  | 76    | 10   | 2    | 0    | 388   |
|                  | An. atroparvus |                  | 0    | 0     | 7    | 14   | 8    | 82   | 59    | 0    | 0    | 0    | 174   |
|                  | An. hyrcanus   |                  | 0    | 0     | 0    | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0     |
| Human landing    | An. melanoon   |                  | -    | -     | 0    | -    | 0    | -    | 0     | -    | -    | -    | 0     |
|                  | An. atroparvus |                  | -    | -     | 0    | -    | 0    | -    | 0     | -    | -    | -    | 0     |
|                  | An. hyrcanus   |                  | -    | -     | 0    | -    | 398  | 35   | -     | -    | -    | 433  |       |
|                  | An. algeriensis|                  | 0    | 0     | 1    | -    | 4    | 0    | 0     | 0    | 0    | 0    | 0     |
| Total            | An. melanoon   |                  | 0    | 6     | 191  | 134  | 464  | 1,073| 105   | 2    | -    | -    | 1,811 |
|                  | An. atroparvus |                  | 0    | 0     | 0    | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0     |
|                  | An. hyrcanus   |                  | 5    | 7     | 296  | 6,737| 17,739| 61,315| 25,708| -    | 124  | 111,931|       |
|                  | An. algeriensis|                  | 43   | 50    | 72   | 2    | 0    | 1    | 2     | -    | -    | 170  |       |
| Marais du Vigueirat| Light trap    | An. melanoon     | 0    | 0     | 0    | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0     |
|                  | An. atroparvus |                  | 0    | 0     | 0    | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0     |
|                  | An. hyrcanus   |                  | 5    | 7     | 296  | 6,737| 17,739| 61,315| 25,708| -    | 124  | 111,931|       |
|                  | An. algeriensis|                  | 43   | 50    | 72   | 2    | 0    | 1    | 2     | -    | -    | 170  |       |
| Resting fauna    | An. melanoon   |                  | 0    | 0     | 1    | 0    | 0    | -    | 398   | 35   | 3    | -    | 433   |
|                  | An. atroparvus |                  | 0    | 0     | 0    | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0     |
|                  | An. hyrcanus   |                  | 0    | 0     | 0    | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0     |
|                  | An. algeriensis|                  | 0    | 0     | 0    | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0     |
| Horse bait       | An. melanoon   |                  | -    | 1     | -    | 1    | 1393 | 17   | -     | -    | -    | -    | 1,411 |
|                  | An. atroparvus |                  | -    | 0     | -    | 0    | 15   | -    | -     | -    | -    | -    | 15    |
|                  | An. hyrcanus   |                  | -    | 0     | -    | 0    | 768  | 88   | -     | -    | -    | 856  |       |
|                  | An. algeriensis|                  | -    | 0     | -    | 0    | 0    | -    | 0     | -    | -    | -    | 0     |
| Human landing    | An. melanoon   |                  | -    | 0     | -    | 0    | 10   | 0    | 0     | 0    | -    | -    | 10    |
|                  | An. atroparvus |                  | -    | 0     | -    | 0    | 0    | 0    | 0     | 0    | 0    | 0    | 0     |
|                  | An. hyrcanus   |                  | -    | 0     | -    | 0    | 7,034| 14   | 14    | -    | 7,062|       |
|                  | An. algeriensis|                  | -    | 1     | -    | 0    | 0    | 0    | -    | -    | -    | -    | 1     |
| Total            | An. melanoon   |                  | 0    | 6     | 174  | 426  | 464  | 2,837| 250   | 7    | 4    | -    | 4,164 |
|                  | An. atroparvus |                  | 0    | 0     | 5    | 6    | 0    | 21   | 20    | 9    | 6    | -    | 67    |
|                  | An. hyrcanus   |                  | 15   | 7     | 299  | 6,737| 17,739| 69,119| 25,810| 138  | 0    | 119,864|       |
|                  | An. algeriensis|                  | 0    | 43    | 51   | 72   | 2    | 0    | 1    | 2    | 0    | -    | 171   |

*: Not done

on the east side of the Marais du Vigueirat where the ‘Crau’ water table appears. This is why this species was captured only at Marais du Vigueirat and particularly in spring. The absence of An. algeriensis in summer could be explained by resurgences being dry during summer due to drought in the South of France.

Anopheles maculipennis s.s. was reported several times in France, but it is associated with fresh water [22]. It was reported only twice near the south coast of France and in fresh water biotopes [15,21]. Moreover, 16 An. maculipennis complex specimens were collected in a horse bait trap in 2004 at Lunel-Viel [23]. Six out of 11 specimens processed by PCR were identified as An. maculipennis s.s. Lunel-Viel is located at the outer limits of the Camargue, in a dry area without any marshes, paddies or pools submitted to salt water table resurgence. The absence of An. maculipennis s.s. in results presented here is in accordance to these environmental differences.

Anopheles claviger s.s., Anopheles petragnani and Anopheles plumbeus have been reported several times in south-east France. They were not captured during the survey conducted in 2005 because their ecological niches were rare or absent of the two sites and this study did not focus on their breeding sites (which correspond to tree holes for An. plumbeus, rivers stream and small, cold and fresh water collection for the others) [14,21,24,25]. However, An. plumbeus and An. claviger, which were considered as secondary vectors, could be more abundant in some others places, and particularly places close to humans.

Anopheles labranchiae has not been recorded in the Camargue and continental France so far, while it is abundant in Corsica, where it is reported in breeding sites such as small pools with fresh water and marshes [14,26,27]. It is also abundant in Italy, particularly in paddies and in rivers and streams [28]. In the context of global warming, distribution of this species has not yet expanded to the
Camargue despite abundance of potential breeding sites, such as paddies.

*Anopheles hyrcanus* and *An. melanoon* presented similar dynamics in the two areas in 2005, although total mosquito numbers were very different. Their populations began increasing in the middle of June, reaching a peak near the middle of August and decreasing drastically in the middle of September (although *An. melanoon* decreased earlier). Dynamics of these species collapsed brutally at the end of July in the two areas without any identified cause (such as wind, temperature, treatment by mosquito pesticide, hygrometry, water supplying of breeding sites, significant modification of *Anopheles* breeding sites or moon cycle).

Populations of resting *An. atroparvus* remained very low until September or October and then presented a peak in October and November although the number of collected specimens remained small. During this period, more *An. atroparvus* were captured at Carbonnière and particularly in one horse shelter. In 1943, Sautet had observed that this species was very abundant in September suggesting a near disappearance of this species since the 1950’s [9].

*Anopheles hyrcanus* presented a huge anthropophily in both areas with spectacular aggressiveness on humans: during this study scientists underwent massive attacks from females of this species. Results from others authors confirm the high level of anthropophily in France in the past or in South Eastern Europe and South Western Asia [20,21,27,29]. It was reported as one of the principal mosquito pests in Northern Greece in 2001 [29]. Unfortunately, only nine *An. hyrcanus* bloodmeals were processed because very few blood-fed *An. hyrcanus* females were captured in light traps. None of these nine blood meals were human demonstrating an opportunistic trophic behaviour of this species.

![Figure 2](image-url)

**Figure 2**
Seasonal dynamics of *Anopheles melanoon* and *Anopheles hyrcanus* at Carbonnière in 2005 (eight traps).
In contrast to An. hyrcanus, An. melanoon only exceptionally bite humans. This is confirmed by blood meal analyses: An. melanoon bite animals, especially big mammals (horses and cows). The high degree of zoophily had already been reported [15,22,27,30].

Parity rates were difficult to assess because sampling methods did not always provide enough mosquitoes suitable for dissection (too few or too dry mosquitoes). When it was possible to determine parity rates based on a robust number of specimens and using the same sampling method (light traps), parity rates were reported as inversely connected to population dynamics. This situation was observed at Marais du Vigueirat for An. hyrcanus (June, July and September), An. melanoon (July and September) and at Carbonnière for An. hyrcanus (July and September). Low parity rates, related to young populations, reflect the growth of populations during summer to reach a peak in August, while higher parity rates in September were related to older and decreasing populations.

**Conclusion**
In the Camargue, a former malaria-endemic area, An. hyrcanus seems to be the only Culicidae likely to play a role in malaria transmission in view of its abundance and anthropophily. However, the experimental susceptibility of An. hyrcanus to infection with P. vivax and P. falciparum strains should be tested for assessing risks for potential transmission of this anthropophilic species. Finally, the «anophelism without malaria» situation is still going on in metropolitan France since malaria elimination, although there is a possibility for local transmission.

**Authors’ contributions**
NP designed the study, carried out field work, analysed data and drafted the manuscript. CT participated to field
Table 2: Blood meal analysis of fed mosquitoes

| Mosquito species       | Study area         | No of mosquitoes | Horse | Bovine | Boar | Mixed | Dog | Other hosts |
|------------------------|--------------------|------------------|-------|--------|------|-------|-----|-------------|
| An. melanoon           | Carbonnière        | 142              | 95    | 41     | 0    | 2    | 0   | 4           |
|                        | Marais du Vigueirat| 84               | 67    | 10     | 0    | 0    | 0   | 0           |
| An. atroparvus         | Carbonnière        | 12               | 10    | 2      | 0    | 0    | 0   | 0           |
|                        | Marais du Vigueirat| 3                | 3     | 0      | 0    | 0    | 0   | 0           |
| An. maculipennis complex| Carbonnière     | 1                 | 9     | 2      | 0    | 0    | 0   | 0           |
|                        | Marais du Vigueirat| 6                | 2     | 1      | 0    | 0    | 0   | 0           |
| An. hyrcanus           | Carbonnière        | 1                | 1     | 0      | 0    | 0    | 0   | 0           |
|                        | Marais du Vigueirat| 8                | 7     | 0      | 0    | 0    | 0   | 0           |

P: Percentage of parous females
No: Number of dissected females
LT: Light trap
RF: Resting fauna
-: Not done

Table 3: Parity rates of Anopheles captured in 2005

|          | Carbonnière | Marais du Vigueirat |
|----------|-------------|---------------------|
|          | An. melanoon| An. atroparvus      |
| Capture  | P | No | Capture  | P | No | Capture  | P | No | Capture  | P | No | Capture  | P | No |
| Mar.     |   |    |          |   |    |          |   |    |          |   |    |          |   |    |
| April    |   |    |          |   |    |          |   |    |          |   |    |          |   |    |
| June     | LT | 0.40 | 5 | - | - | LT | 0.14 | 7 | RF | 0.07 | 30 | LT | 0.68 | 25 |
| July     | LT | 0.50 | 14 | - | - | LT | 0.22 | 87 | LT | 0.29 | 48 | LT | 0.24 | 118 |
| Sept.    | LT | 0.44 | 9 | LT | 0.00 | 1 | LT | 0.67 | 132 | LT | 0.91 | 33 | LT | 0.33 | 118 |
| Oct.     | RF | 0.50 | 32 | RF | 1.00 | 4 | - | - | RF | 0.26 | 19 | - | - | - |
| Dec.     | RF | 0.14 | 7 | RF | 0.00 | 48 | - | - | - | - | - | - | - | - |

P: Percentage of parous females
No: Number of dissected females
LT: Light trap
RF: Resting fauna
-: Not done

(page number not for citation purposes)
work and carried out molecular studies. GLA participated to field work. GLG participated to the design of the study and to the field work. CB participated to molecular studies. FS participated to the conception and to the design of this study. DF conceived of the study, participated in its design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript.

Acknowledgements

We thank Michel Babinot and Didier Caire from the Mosquito Control Department of EID for their precious information and support, Nicolas Sidos at the geographic information department of EID for the map, Jérémiah Petit from the syndicat mixte pour la protection et la gestion de la Camargue gardoise and staff from the Marris du Vigueirat association for their hospitality and information, Thomas Balenghien from the EPSP-TIMC/ENVL, Florence Fouque from the Pasteur Institute for her information on An. maculipennis s.s., Cyrille Thomas from the French Rice Centre for information on paddies, Alain Dervieux for his knowledge of the Camargue and Fabrice Legros for informations concerning imported malaria in France. This work was supported by IRD and was partially funded by the French Ministry of Agriculture and EU grant GOCE-2003-010284 EDEN (the paper is catalogued by the EDEN Steering Committee as [EDEN0038 [31]]). The contents of this publication are the sole responsibility of the authors and can in no way be taken to reflect the views of the European Union.

References

1. WHO – CISID-malaria [http://dtes.euro.who.int/cisid]
2. Cuadros J, Calvente MJ, Benito A, Arevalo J, Calero MA, Segura J, Rubio M: Plasmodium ovale malaria acquired in central Spain. Emerg Infect Dis 2002, 8:1506-1508.
3. Baldari M, Tamburro A, Sabatinelli G, Romi R, Severini C, Cuccagna G, Fiorilli G, Allegri HP, Buriani C, Toti M: Malaria in Maremma, Italy. Lancet 1996, 351:1246-1247.
4. Kampen H, Proft J, Etji S, Matteos E, Pagonas M, Maier WA, Seitz HM: Individual cases of autochthonous malaria in Evros Province, northern Greece: entomological aspects. Parasitol Res 2003, 89:252-258.
5. Krugier A, Rech A, Su X-Z, Tannich E: Two cases of autochthonous Plasmodium falciparum malaria in Germany with evidence for local transmission by indigenous Anopheles plumbeus. Tropical Medicine and International Health 2001, 6:983.
6. Rodhain F, Charmot G: Evaluation des risques de reprise de transmission du paludisme en France. Médecine et Maladies Infectieuses 1982, 12:231-236.
7. Sautet J: Indice de régression et eradicateion du paludisme. Bull Acad Nat Med 1978, 162:839-842.
8. Sautet J, Quilici M: A propos de quelques cas de paludisme autochtone contractés en France pendant l’été. La presse médicale 1971, 79:524.
9. Sautet J: A propos d’une épidémie de paludisme en Camargue. Marseille-Médical 1944, 2:53-64.
10. Danis M, Legros F, Thellier M, Caumes E: Données actuelles sur le paludisme en France métropolitaine. Med Trop (Mars) 2002, 62:214-218.
11. Armengaud A, Legros F, Quatresous I, Barre H, Valayer P, Fenton Y, D’Ortongne E, Schaffner F: A case of autochthonous Plasmodium vivax malaria, Corsica, August 2006. Euro Surveill 2006, 11:E061116-061113.
12. Legros F, Arnaud A, El Minouni B, Danis M: Paludisme d’importation en France métropolitaine : données épidémiologiques 2001–2004. Bulletin épidémiologique hebdomadaire 2006, 32:235-236.
13. Mouchet J: Airport malaria : a rare disease still poorly understood. Euro Surveill 2000, 5:75-76.
14. Schaffner F, Angel G, Geoffrey B, Herry J-P, Rheaim A, Brunhes J: The mosquitoes of Europe. Paris: IRD éditions and EID Méditerranée; 2001.
15. Salieres A, Guy A, Suzzoni Blatger J, Cousserans J, Blagjer J, Suzzoni: Synopsis of four years of research on the ‘maculipennis complex’ (Diptera – Culicidae – Anophelinae). Ann Parasitol Hum Comp 1978, 53:751-756.
16. Sinno G, Riou JA, Salgado J: Fascicule de détermination des principales espèces de moustiques du littoral méditerranéen français. Montpellier, France: Entente Interdépartementale pour la Romousication du Littoral Méditérranéen 1979.
17. Detinova TS: Age-grouping methods in Diptera of medical importance with special reference to some vectors of malaria. Monogr Ser World Health Organ 1962, 17:13-191.
18. Proft J, Maier WA, Kampen H: Identification of six sibling species of the Anopheles maculipennis complex (Diptera: Culicidae) by a polymerase chain reaction assay. Parasitol Res 1999, 85:837-843.
19. Beier JC, Perkins PV, Wirtz RA, Koros J, Digg D, Gargan TP 2nd, Koeh CK: Bloodmeal identification by direct enzyme-linked immunosorbent assay. Euro Surveill 1999, 4:16.
20. Ramsdale CD, Lodge V: Internal taxonomy of the Hyrcanus group of Anopheles (Diptera, Culicidae) and its bearing on the incrimination of vectors of continuing or resurgent malaria in the West of the Palaearctic region. European Mosquito Bulletin 2001, 10:1-8.
21. Riou JA: Les Culicidés du “Midi” méditerranéen. Volume 35. Paris, France: Editions Paul Lechevalier; 1958.
22. Jetten TH, Talken W: Anophelism without malaria in Europe. A review of the ecology and distribution of the genus Anopheles in Europe. Wageningen, Netherlands: Landbouwuniversiteit Wageningen (Wageningen Agricultural University); 1994.
23. Balenghien T, Fouque F, Sabatier P, Picout DJ: Horse, bird and human-seeking behavior and seasonal abundance of mosquitoes in a West Nile virus focus of Southern France. Journal of Medical Entomology 2006, 43:936-946.
24. Kampen H, Sternberg A, Proft J, Bastian S, Schaffner F, Maier WA, Seitz HM: Polymerase chain reaction-based differentation of the mosquito sibling species Anopheles claviger s.s. and Anopheles petragnani (Diptera: Culicidae). Am J Trop Med Hyg 2003, 69:195-199.
25. Ramsdale CD, Snow K: Distribution of the genus Anopheles in Europe. European Mosquito Bulletin 2000, 7:1-28.
26. Aldenk THG: The Culicidées of Sardina and Corsica (Diptera). Bull Entomol Res 1954, 45:437-494.
27. Senevet G, Andarelli L: Les Anophèles de l’Afrique du Nord et du bassin méditerranéen. Volume 33. Paris, France: Editions Paul Lechevalier; 1956.
28. Romi R, Pierdani G, Severini C, Tamburro A, Cocchi M, Menichetti D, Pili E, Marchi A: Status of malaria vectors in Italy. J Med Entomol 1997, 34:263-271.
29. Kaiser A, Jerretspur H, Samanidou Voyadjoglou A, Becker N: Contribution to the distribution of European mosquitoes (Diptera: Culicidae) : four new country records from northern Greece. European Mosquito Bulletin 2001, 10:9-12.
30. Mouchet J, Carnevale P, Coosman M, Julve J, Manguin S, Richard- Lenoble D, Sircoulon J: Biodiversité du paludisme dans le monde. Montrouge, France: John Libbey Eurotext; 2004.
31. Emerging diseases in a changing European environment (EDEN) [http://www.eden-edproject.net/]