AQUATIC HEMIPTERA OF NORTHEASTERN ALGERIA: DISTRIBUTION, PHENOLOGY AND CONSERVATION

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RÉSUMÉ.— *Hémiptères aquatiques du nord-est de l'Algérie : distribution, phénologie et conservation.*— L'échantillonnage de 83 sites à travers le complexe de zones humides du nord-est Algérien, un point chaud de la biodiversité aquatique, a permis d'identifier 35 espèces d'hémiptères aquatiques. La répartition et la phénologie des espèces sont présentées et les histoires de vie de *Notonecta glauca* et *Notonecta obliqua* déduites. Ces deux espèces estivent dans des milieux refuges à hautes altitudes avant de redescendre se reproduire en plaine à l'automne. Diverses manifestations de changements globaux (pompage de l'eau, construction de barrages, introduction d'espèces exotiques et fragmentation des milieux) influencent négativement l'intégrité écologique des milieux de la région étudiée.

SUMMARY.— A survey, involving the sampling of 83 sites, investigated the aquatic hemiptera of northeastern Algeria, a well known hotspot of aquatic biodiversity. The study recorded 35 species with data on distribution and phenology presented and discussed. Aspects of the life history of some species (*Notonecta glauca* and *Notonecta obliqua*) were inferred from their distribution and phenology and they were found to aestivate at high altitude refuges. Insect conservation in North Africa is still embryonic, relying mainly on protected areas to provide surrogate conservation to a rich and diverse group. This is inadequate in view of the current distribution of aquatic insects, often located in unprotected habitats (intermittent streams, temporary pools, dunary ponds) and the fact that diverse manifestations of global changes (loss of habitats due to water extraction and dam construction, invasive species, habitat fragmentation) are fast eroding the biodiversity of protected areas.

Insects are the predominant component of biodiversity in most ecosystems (Berenbaum, 2009; Resh & Cardé, 2009) but have so far attracted far less attention than other more popular taxa, mostly vertebrates. Knowledge of the status of insects of the Maghreb has so far lagged far behind that of charismatic groups like birds but renewed interests in arthropods, prompted by key conservation organizations like IUCN, has to be acknowledged (Samraoui *et al*., 2011b; Clausnitzer *et al*., 2012).

In Algeria, insects have rarely been the focus of notable conservation efforts and major surveys of arthropods have tended to be sporadic. This is the case for the aquatic hemiptera which were mainly investigated in the first part of the twentieth century (Poisson, 1926, 1928, 1929a, b; Poisson & Gauthier, 1926; Eckerlein & Wagner, 1965). Twenty years ago, Tebibel (1992)

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surveyed once again the aquatic hemipteran fauna of Algeria filling in important gaps in our knowledge of the distribution of most species. Despite the cumulated knowledge, a synthesis of the present status and distribution of most species of this group is still lacking. As part of a larger survey of the aquatic fauna of Algeria, we collected data on major habitats within northeastern, principally Numidia and neighbouring regions, including the Constantinois (Samraoui & Menaï, 1999; Samraoui *et al*., 2006; Zerguine *et al*., 2009; Chaïb *et al*., 2011). Knowledge of the status, distribution and life history of aquatic organisms as well as the identification of threats to their habitats are urgently needed to set up conservation strategies in view of the fast disappearing wetlands within the Mediterrean landscapes (Gallego-Fernandez *et al*., 1999).

MATERIAL AND METHODS

The survey is mainly based on a four year sampling effort between 1996 and 1999 but specimens collected before this period (1989-1995) were also included in the present survey. Twice a month during the whole hydroperiod, each site was sampled along a 50 m transect, or following the curving edge of the site, using a dipnet. Ten sweeps of the dipnet were used during each sampling bout. Samples were kept in formaldehyde (4 %) pending sorting and identification in the laboratory. Details about Numidia (Fig. 1) and sampling sites can be found in Samraoui & Bélair (1997, 1998). Oued (wadi), Garaet (pond) and Mare (pool) are abbreviated as O., G. and M., respectively. This study complied with the code for insect collecting (Samways *et al*., 2010).

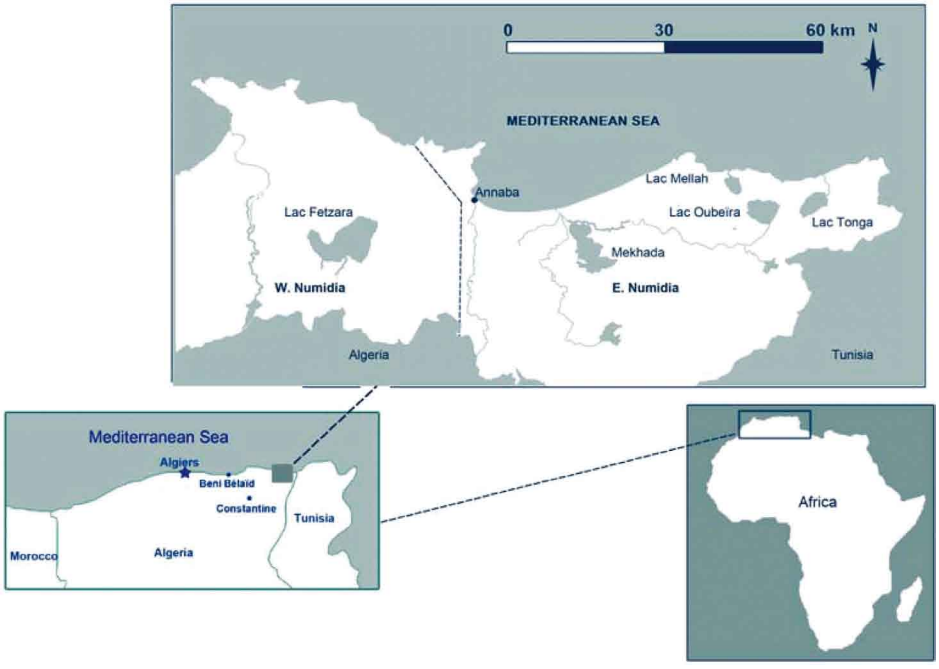

Figure 1.— Location of the study area in northeastern Algeria with a focus on Numidia which housed the majority of sampling sites.

LIST OF LOCALITIES

The Annaba/El Kala wetlands complex, eastern Numidia; prefix 'E' (Samraoui & Bélair, 1998):

1. Lac Tonga (36° 52'N, 8° 31'E): A freshwater shallow lake of 2400 ha with a Ramsar Site status. Dominant vegetation includes *Phragmites australis*, *Scirpus lacustris*, *Nymphaea alba*, *Potamogeton lucens*.

2. Canal Messida (Tonga): A man-made canal dug at the beginning of the twentieth century to drain Lac Tonga (*Nymphaea alba*, *Scirpus lacustris*, *Sparganium erectum*).

3. Lac Oubeïra (36°50'N, 8°23'E): A freshwater shallow lake of 2200 ha with a Ramsar Site status. Dominant vegetation includes *Scirpus inclinatus*, *Scirpus lacustris*, *Ceratophyllum demersum*, *Trapa natans*, *Myriophyllum spicatum*.

4. M. Brabtia: A man-made well devoid of vegetation.

5. Marsh of Lac Mellah: A brackish marsh at the southern end of Lac Mellah (*Juncus maritimus*, *Ranunculus baudotii*).

6. Lac Bleu (36°54'N, 8°20'E): A protected (Ramsar Site) dunary pond of 4 ha with *Phragmites australis*, *Nymphaea alba*, *Ceratophyllum demersum*.

7. M. Lac Bleu: A man-made well (*Iris pseudoacorus*, *Wolffia arrhiza*).

8. Saulaie: A dunary depression adjacent to Lac Bleu and dominated by *Salix cinerea*, *Iris pseudoacorus*, *Carex elata*, *Scirpus lacustris*.

9. M. Fedjoudj (36°51.652'N, 8°15.065'E): A temporary pool (*Typha angustifolia*, *Callitriche obtusangula*).

10. M. Gérard (36°50.594'N, 8°09.587'E): A temporary pool (*Glyceria fluitans*, *Ranunculus baudotii*, *Juncus heterophyllus*).

11. Lac Okréa (36°50.832'N, 8°10.792'E): A dunary pond (*Typha angustifolia*, *Scirpus lacustris*, *Paspalium obtusifolium*, *Juncus effusus*).

12. M. Isoetes (36°50.663'N, 8°08.888'E): A shallow temporary pool with *Isoetes histrix* and *Isoetes velata*.

13. G. El Khobzi: A temporary pond with *Nymphaea alba.*

14. Berrihane Ecole (36°50.469'N, 8°08.089'E): A temporary pool with *Ranunculus baudotii*, *Juncus heterophyllus*, *Glyceria fluitans*.

15. Berrihane Sud (36°50.067'N, 8°06.680'E): A temporary pool with *Glyceria fluitans*, *Chara* sp.

16. El Hrib (36°50.110'N, 8°06.680'E): A temporary pool with *Ranunculus baudotii*, *Glyceria fluitans*, *Juncus heterophyllus*.

17. Carrière (36°50.875'N, 8°04.477'E): A quasi-permanent pool with *Typha angustifolia*.

18. Tamaris (36°51.149'N, 8°04.603'E): A permanant pool with *Sparganium erectum*, *Scirpus lacustris*, *Ranunculus baudotii*.

19. Mare aux Sangliers (36°50.248'N, 7°56.754'E): A permanent brackish pool with *Juncus acutus*, *Tamaris gallica*, *Typha angustifolia*.

20. Mafragh (36°50.440'N, 7°56.875'E): A temporary brackish pool with *Typha angustifolia*, *Juncus acutus*, *Ranunculus baudotii*.

21. El Feid (36°43.970'N, 8°01.739'E): A series of temporary pools with *Ranunculus baudotii*, *Callitriche obtusangula*, *Alisma plantago-aquatica*.

22. Lac des Oiseaux (36° 46'N, 8°07'E): A freshwater pond of 75 ha with a Ramsar Site status, dominated by *Typha angustifolia*, *Scirpus lacustris*, *Nymphaea alba*, *Juncus acutus*.

23. M. aux Frênes (36°46.761'N, 8°16.066'E): A temporary pool within an Ash (*Fraxinus excelcior*) plantation.

24. M. Gauthiers (36°50.243'N, 8°26.611'E): A series of temporary pools with *Glyceria fluitans*, *Ranunculus baudotii*, *Callitriche obtusangula*.

25. M. Messida (Oubeïra) (36°48.769'N, 8°26.611'E): A temporary pool with *Ranunculus baudotii*, *Scirpus lacustris*, *Scirpus maritimus*.

26. G. Estah (36°50.556'N, 7°58.939'E): A dunary pond of 8 ha with *Nymphaea alba*, *Phragmites australis*, *Scirpus lacustris*, *Salix cinerea*, and *Iris pseudo-acorus*.

27. G. Dakhla (36°50.674'N, 7°59.077'E): A dunary pond of 8 ha, adjacent to G. Estah with *Phragmites australis*, *Scirpus lacustris*, *Nymphaea alba*.

28. Mekhada (36° 48'N, 8° 00'E): A vast marsh (protected as a Ramsar Site) of 10 000 ha dominated by *Scirpus maritimus*, *Scirpus lacustris*, *Typha angustifolia*, *Ranunculus baudotii*.

29. Salines (36° 50.374'N, 7° 47.627'E): A hypersaline series of temporary ponds dominated by *Salicornia europea*.

30. O. Bouaroug (36° 51.543'N, 8° 20.219'E): a stream by feeds Lake Mellah.

31. O. Bou Lathan: An affluent of wadi Kebir.

32. O. Dardan: An affluent of wadi Kebir.

33. O. Guergour: An affluent of wadi Kebir.

34. O. Kebir: The major water course in eastern Numidia.

35. O. Degrah: a wadi that feeds Lake Oubeïra, covered by *Nuphar luteum*.

36. O. Bouhchicha: A tributary of wadi Messida, an affluent of wadi Kebir.

37. Ghora (36°37'N, 8°26'E): a temporary pool.

38. Boukhadra (36°52.807'N, 7°44.382'E): A brackish marsh dominated by *Scirpus maritimus* and *Typha angustifolia*.

39. Seraïdi (36°55'N, 7°40'E): a temporary stream.

40. M. Ruppia (36°55'N, 8°20.640'E): A dunary pool dominated by *Ruppia maritima*.

41. M. El Frine: a shallow pool south of Lake Oubeïra.

42. G. Butomes (36° 50.052'N, 8°06'E): A freshwater marsh dominated by *Scirpus maritimus*.

43. Bou Redim (36° 48'N, 8°15'E): A marsh (protected as a Ramsar Site) covered with *Nymphaea alba*, *Salix cinerea*, *Alnus glutinosa*, *Carex elata*, *Scirpus lacustris*.

44. M. Khobzi (36° 51.226'N, 8° 10.494'E): a dunary pool.

45. G. Medjez Ezzitoun: a dunary pond with *Nymphaea alba*.

46. G. Khoud El Barouk: a dunary pond, north of G. Dakhla, with stands of *Carex elata* and *Salix cinerea*.

47. M. Eleocharis: a pool, close to Bou Redim marsh, dominated by *Eleocharis lacustris*, *Alisma plantago-aquatica*.

48. Col du Fedjoudj: a streamlet, feeding O. Mellah, going down from Djebel Koursi.

49. O. Mellah (36° 52.290'N, 8° 19.347'E): An affluent to Lac Mellah.

The Guerbes-Senhadja wetlands complex, western Numidia; prefix 'W' (Samraoui & Bélair, 1997). The whole ecocomplex has been given the status of a protected area (Ramsar site):

1. Lac Sidi Fritis (36°53.975'N, 7°17.437'E): a dunary pond with *Nymphaea alba*, *Ranunculus baudotii*, *Chara* sp.

2. G. Ouajaa (36°53.192'N, 7°18.963'E): a marshy depression with *Scirpus lacustris*.

3. Azla (36°59.477'N, 7°19.541'E): a small pond dominated bt *Alisma plantago-aquatica*.

4. Aïn Magroun (36°50.225'N, 7°16.943'E): a marshy depression with soils made up of clay and silt alluvions. The marsh is adjacent to an olive tree plantation and the surrounding meadows are rich in Graminaceae and Papillionaceae.

5. Aïn Nechma (36°48.837'N, 7°16.728'E): a marshy depression.

6. Bechna (36°53.082'N, 7°17.802'E): a dunary depression with *Isoetes velata*.

7. Boumaïza (36°49.155'N, 7°18.975'E): A temporary brackish marsh heavily grazed by cattle and sheep.

8. G. Hadj Tahar (36°51.774'N, 7°15.957'E): A freshwater marsh with relict alder carrs spread along its banks. The vegetation includes *Nymphaea alba*, *Scirpus lacustris*, *Phragmites australis* and *Iris pseudo-acorus*.

9. G. Sidi Lakhdar (36°54.780'N, 7°12.055'E): A fragmented marsh dotted with wells and pits dug for irrigation purposes. Remnants of relict cork oak forests and alder carrs are still found around the site.

10. G. Chichaya (36°53.791'N, 7°18.230'E): A marsh which follows a gentle slope NW-SE towards the alluvial plain. The vegetation includes *Iris pseudo-acorus*, *Sparganium erectum*, *Scirpus lacustris* and *Phragmites australis.*

11. G. Sidi Makhlouf (36°53.094'N, 7°18.248'E): This marsh, flanked by a relict alder carr, is similar to the adjacent site G. Chichaya and is dominated by *Scirpus lacustris* with open areas covered by *Nymphaea alba*.

12. La Marsadelle (37°00.815'N, 7°15.637'E): A temporary dunary pond open towards the sea and maintained by ground water and a stream.

13. G. Bordj du Cantonnier (36°52.168'N, 7°22.760'E): a very shallow pond almost devoid of helophytes.

14. G. Tacha (36°51.979'N, 7°23.587'E): A narrow marsh with a substratum made up of clayey schist.

15. G. Loughat (36°50'N, 7°23.587'E): A temporary marsh fed by a streamlet.

16. G. aux Linaires (36°52'N, 7°18'E): A dunary pond dominated by *Isoetes velata*, *Eleocharis palustris* and with deeper parts covered by *Nymphaea alba*.

17. G. Bouina (36°53.490'N, 7°17.574'E): A dunary pond with substratum made up of sand, peat (SE) and clay (NW).

18. G. Nouar Ezzouaoua (36°54.188'N, 7°12.463'E): A temporary marsh reduced to three artificial water holes for irrigation.

19. G aux Oliviers (36°50'N, 7°18'E): A freshwater marsh surrounded by an olive grove.

20. G. Beni Mhamed (36°57'N, 7°16'E): This brackish marsh is dominated by halophilic plants.

21. G. El Guelb (36°53.206'N, 7°18.538'E): A marshy depression dominated by *Scirpus lacustris*.

22. Demnat Ataoua (36°56.132'N, 7°14.780'E): This site is noteworthy for its alder carr and brackish marsh. The soil is sandy in the NW and it gradually becomes clayey in the SE owing to the alluvial deposits of wadi Kébir.

23. Canal Sidi Makhlouf (36°53.295'N, 7°18.478'E):

24. G. Khedidja: A dunary depression.

25. G. Khemissa: A dunary depression.

26. G. Grand Bleu: A deserted sand quarry, close to G. Sidi Makhlouf, fed by ground water and devoid of halophytes.

27. M. Nord Fetzara: A temporary pool, north of Lake Fetzara.

Wetlands around Constantine; prefix 'C':

1. O. Dekri (36°14'30.59''N, 6°06'43.81îE, altitude: 811 m): a wadi.

2. Aïn Smara (36°16' 54.17''N, 6°30' 54.96''E, altitude: 598 m): a wadi with residual pools.

3. Ben Yahia Abderrahmane (36°14'05.16''N, 6°00'43.28''E, altitude: 965m): a shallow pond covered by *Lemna* sp.

The Beni-Belaïd wetland (36° 52.511'N, 6° 6.086'E) east of Jijel; prefix 'J':

1. Beni Belaïd: a pond dominated by *Scirpus lacustris*, *Typha angustifolia* and *Phragmites australis*.

RESULTS

A total of 35 species was recorded during this survey (Tab. I). Previous known localities are presented in Table II whereas biogeographic origins and adult phenology are provided in Table III. Many species were found to be widespread: *Corixa affinis*, *Plea minutissima*, *Anisops sardea, Gerris thoracicus, Corixa panzeri*, and *Notonecta glauca* (Fig. 2). Although the true status of species and sites has to await a systematic sampling (Blaustein & Spencer, 2005) of the region, the survey revealed that many habitats house an important number (over ten) of species: O. Bouaroug (loc. E30), Canal Messida (loc. E2), M. Lac Bleu (loc. E6), Saulaie (loc. E8), Lac Tonga (loc. E1), Lac Bleu (loc. E6), Lac Okréa (loc. E11), Carrière (loc. E17), Tamaris (loc. E18) and M. Gauthiers (loc. E24).

TABLE I

Check-list of aquatic hemiptera with their recorded localities in northeastern Algeria

	Species	Localities
1	*Hydrocyrius columbiae* Spinola	E(1-3, 6-8, 18, 26, 27); W(2, 8), C(3)
2	*Nepa cinerea* Linné	E(1, 2, 5, 14, 16, 19, 22, 27, 30, 49); W(3, 5, 7, 10, 13, 14, 25); C(2)
3	*Ranatra linearis* Linné	E(2, 4, 5, 9, 14, 17, 18, 24, 27, 30, 31, 33, 40); C(3)
4	*Corixa punctata* (Illiger)	E(10-12, 14, 17, 18, 21); W(1, 6, 7, 25); C(2)
5	*Corixa panzeri* (Fieber)	E(1-4, 6-8, 10-12, 14-22, 24, 26-31, 38, 40, 43), W(1,4, 7-9, 12, 17-19, 21, 25)
6	*Corixa affinis* Leach	E(2, 4-12, 14-22, 24-30, 36, 38, 40, 41, 43-47), W(1, 3-11, 13-21, 23-27)
7	*Hesperocorixa linnaei* (Fieber)	E(1-4, 6-8, 10, 11, 15, 18-21, 24-27, 30, 40, 41), W(11, 17, 19, 20, 22, 26)
8	*Hesperocorixa moesta* (Fieber)	E(1, 3, 4, 6-12, 14-18, 24, 26-28, 30, 40, 45, 49), W(1, 2, 21)
9	*Hesperocorixa furtiva* (Horvath)	E(2, 4,7, 8, 26, 30), C(2)
10	*Sigara scripta* (Rambur)	E(6, 30)
11	*Sigara nigrolineata* (Fieber)	E(7, 8, 11, 29, 30, 33)
12	*Sigara lateralis* (Leach)	E(2, 3, 5, 7-9, 11, 16, 17, 20, 22, 29, 30, 40, 41)
13	*Parasigara favieri* (Poisson)	E(1, 8, 27, 30), C(2)
14	*Micronecta scholtzi* (Fieber)	E(6)
15	*Micronecta* sp	E(6, 30, 33)
16	*Notonecta viridis* Delcourt	E(9, 11, 14, 16-19, 21, 29, 33, 38), W(5, 7), C(2)
17	*Notonecta glauca* Poisson	E(5-12, 14-18, 20, 21, 23, 24, 26-31, 35-40), W(7, 26), C(2)
18	*Notonecta meridionalis* Poisson	E(1, 6-15, 17-21, 24, 27, 30, 37, 40, 45), W(1, 7, 14), C(2)
19	*Notonecta maculata* Fabricius	C(1-3), O(1)
20	*Anisops sardea* Herrich-Schaffer	E(1-12, 14-27, 29-31, 35, 38, 40-42), W(1, 6, 7, 9, 12, 14, 18, 20, 26)
21	*Nychia marshalli* Scott	E(34), O(2, 3)
22	*Plea minutissima* Leach	E(1-12, 14-24, 26, 27, 29-31, 38, 40-42), W(1, 3-5, 7, 8, 12-15, 23), C(2, 3)
23	*Naucoris maculatus* Fabricius	E(1-3, 6-9, 11, 14, 16-20, 24, 26, 27, 30, 37, 40, 42, 49), W(7, 8, 10, 11, 22)
24	*Hydrometra stagnorum* (Linné)	E(4, 5, 8, 17, 24, 30-32, 34, 35, 37, 39, 49), W(4, 7, 18), C(1)
25	*Gerris thoracicus* Schummel	E(1-12, 14-21, 23-30, 33, 38, 40, 43, 47, 49), W(4-7, 14, 16, 19)
26	*Gerris gibbifer* Schummel	E(2, 5, 7, 9, 19, 23, 24, 30, 37), W(7, 14, 18), C(2)
27	*Gerris brasili* Poisson	C(2)
28	*Gerris lateralis* Schummel	E(30)
29	*Gerris argentatus* Schummel	E(2, 30, 37), C(2)
30	*Aquarius cinereus* (Puton)	E(5, 37)
31	*Aquarius najas* (de Geer)	E(34)
32	*Mesovelia vittigera* Horvath	E(1, 2, 4-11, 14-18, 21, 24, 25, 28-31, 40, 49)
33	*Microvelia pygmaea* Dufour	E(1, 2, 5, 7, 24, 30), W(7), C(2)
34	*Velia africana* Tamanini	E(37, 39, 48)
35	*Velia concii* Tamanini	C(2)

TABLE II

Previous known localities of recorded aquatic hemiptera of northeastern Algeria

	Species	Previous known localities
1	*Hydrocyrius columbiae* Spinola	«Environ d'Annaba et El Kala» (Seurat, 1930)
2	*Nepa cinerea* Linné	Around El Kala (Poisson & Gauthier, 1926)
3	*Ranatra linearis* Linné	E(3), (Poisson & Gauthier, 1926); pool near E(3) (Tebibel, 1992)
4	*Corixa punctata* (Illiger)	Around El Kala (Poisson & Gauthier, 1926);
5	*Corixa panzeri* (Fieber)	Pools near E(2, 3) (Tebibel, 1992)
6	*Corixa affinis* Leach	E(1, 3, 5), Oued Seybouse, Tebessa, Souk Ahras (Poisson & Gauthier, 1926); pool near E(3), wadi and pool at Benazouz (Tebibel, 1992)
7	*Hesperocorixa linnaei* (Fieber)	Pool near El Kala (Poisson & Gauthier, 1926; Janson, 1986); pool near E(3), wadi and pool at Benazouz, pool near Jijel (Tebibel, 1992)
8	*Hesperocorixa moesta* (Fieber)	Pool near E(3) (Tebibel, 1992)
9	*Hesperocorixa furtiva* (Horvath)	Skikda (Poisson & Gauthier, 1926; Jansson, 1986); pool near E(3), O. Benazouz, O. Boumerzoug (Tebibel, 1992)
10	*Sigara scripta* (Rambur)	Pool near E(3), O. Boumerzoug, O. Rhummel (Tebibel, 1992)
11	*Sigara nigrolineata* (Fieber)	O. Boumerzoug, pool Emir Abdelkader (Tebibel, 1992)
12	*Sigara lateralis* (Leach)	E(1, 3, 5), Souk Ahras (Poisson & Gauthier, 1926; Eckerlein & Wagner, 1965); pool near E(3, 28), wadi and pool near Benazouz, O. Rhummel, pool Emir Abdelkader (Tebibel, 1992)
13	*Parasigara favieri* (Poisson)	E(39) (Poisson, 1939, Jansson, 1986); El Kala, Skikda (Jansson, 1986)
14	*Micronecta scholtzi* (Fieber)	E(3, 5), Fetzara (Poisson & Gauthier, 1926), E(22) (Poisson, 1928, Jansson, 1986)
15	*Micronecta* sp	New to the area
16	*Notonecta viridis* Delcourt	O. Rhummel (Tebibel, 1992)
17	*Notonecta glauca* Poisson	Bou Liff, O. Boudjema (Poisson & Gauthier, 1926); pool near E(3), O. Boumerzoug (Tebibel, 1992)
18	*Notonecta meridionalis* Poisson	Bou Liff (Poisson & Gauthier, 1926), pool near E(3) (Tebibel, 1992)
19	*Notonecta maculata* Fabricius	O. Nil (Poisson & Gauthier, 1926), O. Rhummel (Tebibel, 1992)
20	*Anisops sardea* Herrich-Schaffer	E(1, 2, 3, 22, 35), O. Boudjema (Poisson, Gauthier, 1926); O. Messida, pool near E(3), E(28), pool and small dam at Emir Abdelkader, pool at El Aouana (Tebibel, 1992)
21	*Nychia marshalli* Scott	New to the area
22	*Plea minutissima* Leach	E(3, 22), W(1), Bou Liff, pool near Bordj Caïd Lakhdar, O. Boudjema, O. Seybouse (Poisson & Gauthier, 1926), E(1, 3), pool near E(3), O. Boumerzoug, small dam near Emir abdelkader (Tebibel, 1992)
23	*Naucoris maculatus* Fabricius	E(3, 22), Lake Fetzara, O. Nil (Poisson & Gauthier, 1926), E(1, 3, 28), pool near E(3), O. Zenati, O. Boumerzoug, small dam Emir Abdelkader, guelta El Aouana (Tebibel, 1992)
24	*Hydrometra stagnorum* (Linné)	Bou Liff (Poisson & Gauthier, 1926), O. Abdellah, O. Boumerzoug (Tebibel, 1992)
25	*Gerris thoracicus* Schummel	Pool at Bou Liff (Poisson & Gauthier, 1926), pool near wadi O. Messida (Tebibel, 1992)
26	*Gerris gibbifer* Schummel	Pool near E(3), Souk Ahras, (Poisson & Gauthier, 1926)
27	*Gerris brasili* Poisson	New to the area
28	*Gerris lateralis* Schummel	Wadi Maboun (Poisson & Gauthier, 1926)
29	*Gerris argentatus* Schummel	O. Nil (Poisson & Gauthier, 1926)
30	*Aquarius cinereus* (Puton)	O. Seybouse, O. Constantine, O. Nil (Poisson & Gauthier, 1926); O. Seybouse, O. Mencha, O. Ziama Mansouriah (Tebibel, 1992)
31	*Aquarius najas* (de Geer)	Stream at Skikda (Poisson & Gauthier, 1926), O. Abdellah, O. Teboula (Tebibel, 1992)
32	*Mesovelia vittigera* Horvath	E(3), O. Boudjema (Poisson & Gauthier, 1926), O. Messida, pool near E(3), E(1, 6), O. Zenati, O. Boumerzoug, guelta Emir Abdelkader, Guelta El Aouana (Tebibel, 1992)
33	*Microvelia pygmaea* Dufour	E(2) (Poisson & Gauthier, 1926)
34	*Velia africana* Tamanini	Spring at Djebel Thar, O. Teboula(Tebibel, 1992)
35	*Velia concii* Tamanini	Tebessa (Tebibel, 1992)

TABLE III

Biogeographical origin and phenology of recorded aquatic hemiptera

	Species	Biogeographical origin	Phenology
1	*Hydrocyrius columbiae* Spinola	Afrotropical	January, April, June, August-December
2	*Nepa cinerea* Linné	Palearctic	January-December
3	*Ranatra linearis* Linné	Palearctic	January-September, December
4	*Corixa punctata* (Illiger)	Palearctic	January-March, April-August, October-December
5	*Corixa panzeri* (Fieber)	Palearctic	January-March, May-December
6	*Corixa affinis* Leach	Palearctic	January-February
7	*Hesperocorixa linnaei* (Fieber)	Palearctic	January-March, May, August-December
8	*Hesperocorixa moesta* (Fieber)	Western Palearctic	January-April, August-October, December
9	*Hesperocorixa furtiva* (Horvath)	North Africa and the Iberian Peninsula	January-August, November-December
10	*Sigara scripta* (Rambur)	Palearctic	January-March
11	*Sigara nigrolineata* (Fieber)	Palearctic	January, June, September-October
12	*Sigara lateralis* (Leach)	Palearctic	January, May-July, September-December
13	*Parasigara favieri* (Poisson)	Western Palearctic	May, July, September, November-December
14	*Micronecta scholtzi* (Fieber)	Palearctic	August
15	*Micronecta* sp		October-November
16	*Notonecta viridis* Delcourt	Palearctic	January-April, June-September, December
17	*Notonecta glauca* Poisson	Palearctic	January-December
18	*Notonecta meridionalis* Poisson	Mediterranean	January-September, December
19	*Notonecta maculata* Fabricius	Western Mediterranean	January-April, June-December
20	*Anisops sardea* Herrich-Schaffer	Paleotropical	January-December
21	*Nychia marshalli* Scott	Afrotropical	July-September
22	*Plea minutissima* Leach	Palearctic	January-December
23	*Naucoris maculatus* Fabricius	Paleomediterranean	January-December
24	*Hydrometra stagnorum* (Linné)	Palearctic	January, March-September
25	*Gerris thoracicus* Schummel	Palearctic	January-July, October, December
26	*Gerris gibbifer* Schummel	Palearctic	February-June, August
27	*Gerris brasili* Poisson	North Africa and the Iberian Peninsula	March, June-August
28	*Gerris lateralis* Schummel	North African endemic	June-July
29	*Gerris argentatus* Schummel	Palearctic	March-September
30	*Aquarius cinereus* (Puton)	Circummediterranean	May, July
31	*Aquarius najas* (de Geer)	Western Palearctic	November
32	*Mesovelia vittigera* Horvath	Palearctic	June-January
33	*Microvelia pygmaea* Dufour	Palearctic	January, March, June-October, December
34	*Velia africana* Tamanini	Algerian endemic	May-June, August
35	*Velia concii* Tamanini	North Africa and Sicily	January-February

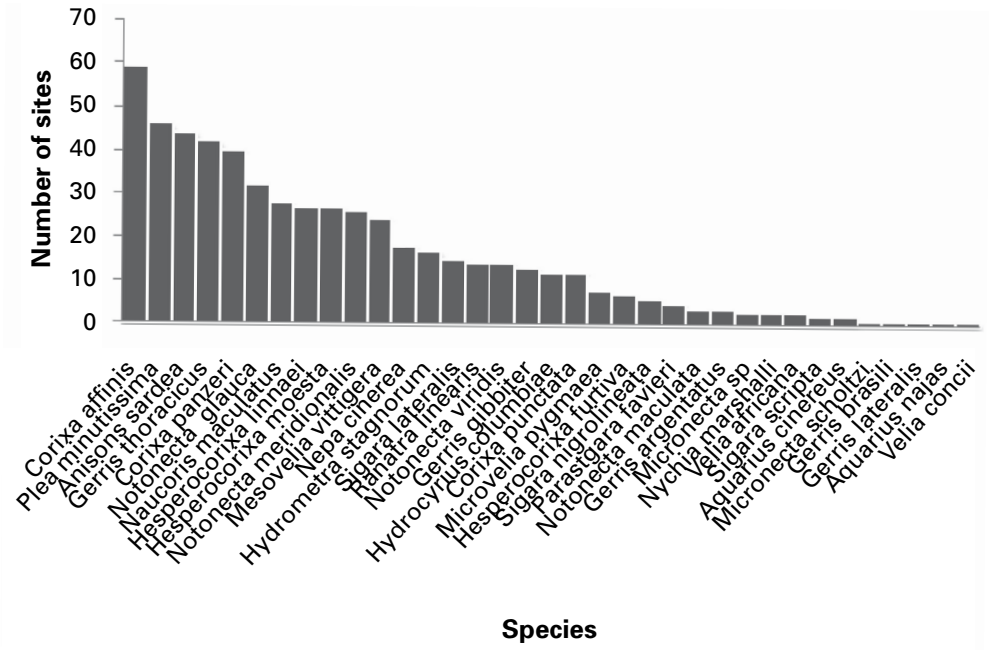

Figure 2.— Frequency distribution of aquatic hemiptera across wetlands of northeastern Algeria.

We did not record the following nine species, previously known from northeastern Algeria (Tebibel, 1992):

– *Micronecta minutissima* Linné.— Babors: Poisson & Gauthier (1926).

– *Cymatia rogenhoferi* (Fieber).— El Kala: Jansson (1986).

– *Sigara stagnalis* (Leach).— Tonga, Lac Bleu, Mekhada, Bennazouz, Fetzara: Poisson & Gauthier (1926); Jansson (1986); Tebibel (1992).

– *Parasigara* transversa (Fieber).— El Kala: Poisson & Gauthier (1926).

– *Gerris maculatus* Tamanini.— Annaba: Oued Mencha near Jijel, Mizrana, Lac Goulmine: Tebibel (1992)

– *Gerris lacustris* Linné.— Tonga, Degrah: Poisson & Gauthier (1926).

– *Mesovelia furcata* Mulsant & Rey.— Mabour, Boudjema: Poisson & Gauthier (1926).

– *Velia noualhieri* Puton.— Oued Ziama Mansouriah: Poisson & Gauthier (1926).

– *Velia rivulorum* (Fabricius).— El Kala, spring at Djebel Ther, O. Tebula, Tala Kitane, Tala Guilef, Yakouren, O. between Yakouren and El Kseur: Poisson & Gauthier (1926); Tebibel (1992).

DISCUSSION

This survey has recorded 35 species of aquatic hemiptera but if a further nine species, previously known from northeastern Algeria (Poisson & Gauthier, 1926; Tebibel, 1992), are taken into account, the total number of recorded aquatic hemiptera for the area would amount to 44 species. Thus, out of a total number of 80 species (Poisson & Gauthier, 1926; Tebibel, 1992), a large proportion (55.5 %) of the Algerian species is found within the studied region. This percentage falls short from that found for other taxa like Odonata where the number noted within the same region amounts to over 80 % (Samraoui & Corbet, 2000). This fact underlines

the importance of the wetland complex of the region especially when these results include data for a variety of other taxa: zooplankton and large branchiopods (Samraoui *et al*., 1998b), amphibians (Samraoui *et al.,* 2012) and waterbirds (Samraoui & Samraoui, 2008; Samraoui *et al.,* 2011a).

Some species like *Notonecta maculata* and *Velia concii* are only found in the Hauts Plateaux. Others like *Hydrocyrius columbiae*, *Ranatra linearis*, *Hesperocorixa linnaei*, and *Micronecta scholtzi* are confined to the coastal wetlands. Although abundance and range size are closely related (Holt *et al*., 2002), a third group which includes species like *Corixa punctata*, *Corixa panzeri*, *Notonecta glauca*, *Notonecta meridionalis* and *Mesovelia vittigera,* were found in both Numidia and the Hauts Plateaux but were clearly more abundant in the former region. Factors like altitude constrain the distribution of *Velia africana* and *Velia concii*, restricted to hilly streams.

One species, the Afrotropical relict *Hydrocyrius columbiae* (Fig. 3), presumed extinct by Tebibel (1992), was found to be relatively common in large waterbodies and was even located further west from the area where it was previously recorded (Beni Belaid). It is not known whether the species is in the process of extending its range or whether it was overlooked by previous surveys. This is true for a great number of other species (e. g. *Notonecta viridis*, *Anisops sardea*, *Nychia marshalli*, *Hydrometra stagnarum*) and the most likely explanation for the new records is that past sampling efforts were probably inadequate in view of the extent of terrain to be covered in a vast country like Algeria.

Figure 3.— *Hydrocyrius columbiae*, an Afrotropical relict belostomid.

Algeria is also a biogeographic crossroads with a few endemic species (*Velia africana* and *Velia concii*) and many others originating from different biogeographic realms: Palearctic, Mediterranean, Paleotropical, endemic, Eurosiberian (Tab. III). The study area is a noted Afrotropical relict pocket housing the belostomid *Hydrocyrius columbiae* but also numerous other Afrotropical insects (Samraoui *et al*., 1993) and zooplankton (Samraoui *et al*., 1998b).

If preliminary analysis indicates that numerous factors (altitude, size of wetland and vegetation) structure species organization, future work based on a systematic sampling is needed to unravel the complex set of environmental factors (conductivity, organic matter, area,

vegetation, predation) which is known to influence species association (Bennett & Streams, 1986; Savage, 1990). Niche partitioning in corixids has intrigued past illustrious limnologists with the distribution pattern of *Corixa punctata*, *C. affinis* and *C. panzeri* providing a case study for a seminal paper by Hutchinson (1959) devoted to the problems of species diversity and community structure. In Numidia, although all three corixids were found on numerous occasions to coexist in the same habitat, the larger species *C. punctata* was always rare and infrequent, supporting Hutchinson's assertion. When habitats were shallow or had a short hydroperiod (3-4 months), all three large species gave way to smaller species like *Hespecorixa moesta* and *Hespecorixa linnaei*.

Aquatic hemiptera are predated by a wide range of vertebrates including fish (Batzer *et al.,* 2000) and waterbirds (Bendell & McNicol, 1995). Fish are known to influence community structure in freshwater ecosystems by affecting the distribution and abundance of aquatic hemiptera (Weir, 1972; Bendell, 1986). The influence of waterbirds on aquatic communities is no less important (Hurlbert *et al*., 1986) and a number of species (*Nepa cinerea*, *Naucoris maculatus*, *Corixa punctata*, *Corixa affinis*, *Anisops sardea*) are preyed upon by various species of herons with the Squacco Heron *Ardeola ralloides* Scopoli specializing in predating larvae of different developmental stages of *Hydrocyrius columbiae* (Samraoui Chenafi, 2009). In some salt lakes, smaller corixids (*Sigara* spp.) form a staple food for the Greater Flamingo *Phoenicopterus roseus* Pallas (Samraoui, unpubl.).

In order to cope with the transient nature of their habitats aquatic insects have adopted distinct strategies (Williams, 2006). Under the Mediterranean climate with the constraint of surviving a dry and hot summer, aquatic hemiptera have mature adults occupying waterbodies as soon as these fill up (late autumn/winter). They reproduce and larval development proceeds until emergence, in spring, when the waterbodies start to dry up. Many species probably disperse to permanent waterbodies (Weir, 1966) but some were found to adopt a similar strategy followed by several species of dragonflies (Samraoui *et al*., 1998a; Samraoui, 2009). *Notonecta glauca* and *Notonecta meridionalis* undergo a prolonged maturation for several months in streams at high altitude to bridge the dry summer. Dissection of aestivating adults indicated that they were all immatures (Samraoui, unpubl.). Thus, the two species are univoltine and they undergo a seasonal migration to aestivating sites upon emergence before pools dry up and return to breeding lowland pools once these are filled up by autumn rainfall. Preliminary data suggest that *Notonecta maculata* follows the same strategy in the semi-arid Hauts Plateaux (Samraoui, unpubl.). Hutchinson (1933) described a similar adaptation for *Notonecta lactitans* Kirkaldy in South Africa. In contrast, Cayrou & Cereghino (2005) found *Notonecta maculata* to exhibit bivoltinism in permanent ponds in south-western France. This apparent discrepancy can be explained by variation in the severity of the unfavourable season (summer in North Africa) at different latitudes which can lead to distinct adaptations exhibited by individuals of the same species (Leather *et al*., 1996; Masaki, 1999; Corbet, 2004).

Only 12 % of the sites found in eastern Numidia have a formal protection by being designated 'Ramsar Sites'. Conservation of Mediteranean biodiversity has perceptibly evolved with the recent interest in developing Red Data Lists for water plants and invertebrates (Riservato *et al*., 2009; Garcia *et al*., 2010). Previously, protected areas were generally assumed to afford conservation to insects or other invertebrates through habitat protection set up for vertebrates (with a clear focus on waterbirds). It is now recognized that additional management is commonly needed to cater for insect specific needs (New, 2007).

Conferring surrogate protection to a wide range of aquatic organisms through the prism of waterbird conservation and their habitats is clearly inadequate for numerous reasons: 1. Most wetlands of value to insects are unprotected and those found in National parks are not adequately managed (a policy of *laissez faire* is the rule). 2. Temporary pools which are a characteristic feature of the North African landscape are the main habitat for zooplankton, aquatic insects and rare endemic amphibians like *Pleurodeles poireti* Gervais. They are so far ignored by local conservation legislation. 3. Dunary ponds are another important habitat of limited value for waterbirds but which house many Afrotropical relict insect species which include dragonflies (like the Critically Endangered *Urothemis edwardsi* Selys or the Endangered *Acisoma panorpoides* Rambur) and aquatic beetles (like *Cybister bimaculatus* Aubé or *Cybister vulneratus*

Klug). 4. High altitude intermittent streams which harbor endemic species like *Velia africana* and serve as aestivating refuges are undergoing major habitat changes through forest fires and overgrazing. 5. Protected habitats in Algeria and North Africa, as elsewhere, face tough challenges exerted by global changes (man encroachment, invasive species, fragmentation due to road construction, climate change, etc.). Habitat loss through water extraction and dam building constitute the major threat to the perenity of wetlands and climate change is predicted to exacerbate this adverse trend (Hulme *et al*., 2001). Another detrimental influence is the introduction of fish, mainly Asian carps and the Mosquitofish *Gambusia holbrookii* Girard. Both Common Carp *Cyprinus carpio* Linnaeus and the Mosquitofish are now well established. Impact of introduced arthropods remains a threat but our survey did not record the invasive corixid *Trichocorixa verticalis verticalis* (Fieber), a native of North America, which is gradually expanding its range (Rabitsch, 2008). This exotic species which has spread to South Africa and Western Europe has gained a foothold in Morocco but has, so far, not reached northeastern Algeria (Jansson & Reavell, 1999; Kment, 2006; Rodriguez-Pérez *et al*., 2009).

As a hotspot of biodiversity, the region is under intensive pressure from global changes which will fast erode its values and ecosystem services unless decisive and enlightened measures (ecological monitoring, Red Lists, habitat restoration, etc.) are promptly taken (Samways *et al.*, 2010).

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