https://doi.org/10.30456/AVO.2020202 Avocetta 44: 87-93 (2020)

# First Record of Eurasian Spoonbills *Platalea leucorodia* feeding on Branchiopoda in a temporary wetland

Salvatore Surdo[1]*

[1]Department of Agriculture, Food and Forest Sciences, University of Palermo - Viale delle Scienze, 90128 Palermo, Italy
*corresponding author: salvatore.surdo@unipa.it

0000-0002-0300-837X

**Abstract -** The diet of the Eurasian Spoonbill *Platalea leucorodia* is poorly documented with only the most common prey groups known, namely small fishes, amphibians, reptiles, crustaceans, molluscs, worms, leeches and plant material. Here, three small crustaceans, Branchiopoda *Triops cancriformis* (Notostraca), *Chirocephalus diaphanus* (Anostraca), and *Cyzicus tetracerus* (Spinicaudata) are documented as prey of the Eurasian Spoonbill in a temporary wetland near the San Teodoro salt pan (Marsala, western Sicily). These observations provide a new insight into the foraging ecology of the species, showing its extreme opportunism in targeting small prey when feeding in a temporary wetland system.

**Keywords:** *Triops*, Notostraca, Anostraca, Spinicaudata, foraging, western Sicily

The diet of the Eurasian Spoonbill, *Platalea leucorodia*, is poorly known (see Tab. 1). Commonly recognized prey include small fishes, amphibians, reptiles, crustaceans, clams, worms, leeches and plant materials (Cramp & Simmons 1977). However, among crustaceans, the only prey recorded till now have been the Malacostraca, (*Procambarus clarkii, Carcinus maenas, Crangon crangon*) and some species of the Palaemonidae (Tinbergen 1933, Kemper 1986a, 1986b, Aguilera et al. 1996, Wintermans & Wymenga 1996, Altenburg & Wymenga 1997, Veen et al. 2012, Jouta et al 2018, Enners et al. 2020). Additionally, in Europe, among the freshwater crustaceans, three alien species, namely the *Procambarus clarkii*, the *Orconectes limosus* (originating from North America), and the *Macrobrachium sintangense* (from south-east Asia), have been identified as a Spoonbill's prey. Here, for the first time, we document that Eurasian Spoonbills prey on tiny crustaceans living in small temporary wetlands – a habit that suggests an opportunistic ability of the documented birds to benefit from the dense fauna present in such extreme sites.

On the 27th of February 2017, six Eurasian Spoonbills in pre-breeding migration were observed feeding in a temporary freshwater wetland (37°54'38"N 12°28'07"E), near the San Teodoro salt pan (Marsala, Sicily), a site where fish fauna is clearly absent. At the time of our observation the wetland occupied an area of approximately fifty square meters (50 $m^2$). However, based on the distribution of the hygrophilous vegetation, we estimate that the wetland originally occupied an area of approximately one hectare (10000 $m^2$). After 30 minutes of surveillance the Eurasian Spoonbills flew away providing an opportunity to assess their prey options in this novel

environment. Direct observation of the fauna in the feeding areas was performed, a method that is arguably the most used (Tab 1, Kemper 1986a, 1986b, van Wetten & Wintermans 1986a, 1986b) although other more invasive techniques are also employed, such as visual observations of ingested items (van Wetten & Wintermans 1986a, 1986b) or examination of the stomach content of a dead Spoonbill (Tinbergen 1933). Samples of the fauna populating the same areas where birds were feeding were immediately collected with a fine-meshed aquarium net, resulting in 12 samples. The samples were preserved in an ethanol-water solution (90% by volume) and identified using optical microscopy according Alonso (1996), before being stored in the F. Marrone collection at the Department of Biological, Chemical and Pharmaceutical Sciences and Technologies, University of Palermo (Italy).

The samples consisted of smalls crustaceans belonging to the genus *Triops* (N = 3), *Chirocephalus* (N = 6)*, Cyzicus* (N = 2) and 1 larva of a damselfly *Ischnura genei*. Consequently, the most abundant prey available for the Spoonbills were Branchiopoda (i.e., crustaceans), which had likely concentrated in the flooded area upon drought-action. The precise composition of the crustaceans included Notostraca *Triops cancriformis* (up to 70 mm in length excluding cercopods)*,* Anostraca *Chirocephalus diaphanus* (up to 42 mm in length) see Fig. 1A, and Spinicaudata *Cyzicus tetracerus* (up to 20 mm in length) see Fig. 1B (F. Marrone, *pers. comm.*). Importantly, much smaller branchiopods with lengths between 1-4 mm such as *Pleuroxus letourneuxi, Coronatella elegans, Macrothrix hirsuticornis* and *Ceriodaphnia* cf. *quadrangula* (Anomopoda), as well as ostracods and unidentified cyclopoid copepods (F. Marrone, *personal observation*), had been previously sampled in the same pond a year earlier. This result further corroborates our idea that a rich fauna of Branchiopoda populates the site of our observations. Although there is no direct evidence that the Branchiopoda have been preyed on by the Spoonbills, they were the only possible prey discovered in the pond during the observation period. Spoonbills are regularly present nearby the observation site during migration and winter (mean number: 30, range: 1-105 individuals between Jan 2013-May 2020, 77 pers. obs.) (Ientile et al. 2020, Zenatello et al. 2014). However, they have never been observed before feeding in temporary wetlands, where other species such as Redshank *Tringa totanus*, Great Egret *Casmerodius albus*, Curlew *Numenius arquata*, Common Snipe *Gallinago gallinago*, small flocks of Golden Plover *Pluvialis apricaria* and Northern Lapwing *Vanellus vanellus* are instead commonly present. This is also consistent with previously reported observations (Horvàth et al. 2013). Indeed, the presence of crustacean subphylum, specifically of the Branchiopoda class, in the diet of some birds, including those mentioned above, has been already proven. Among the thirty-two waterbird species that potentially feed on Anostraca and⁄or zooplankton, the Curlew and the Common redshanks *Tringa totanus* – the most frequent wader – are two representative examples observed in some European soda pans (Horvàth et al. 2013).

More recently, on the 26$^{th}$ of March 2018, we observed two Spoonbills, during pre-breeding migration feeding, in a temporary freshwater pond (37°56'23"N 12°35'23"E) near the water reservoir of Paceco (Sicily). The maximum extent of this reservoir, based on the distribution of the hygrophilous vegetation, is estimated at half a hectare (5000 m$^2$). The behavior of the two Spoonbills when feeding, namely quickly skimming the water surface, suggested ingestion of small prey rather than larger animals, such as amphibians or reptiles, which usually require longer ingestion times (Pigniczki 2017.). This is consistent with the main fauna of Branchiopoda observed in this pond that, similar to the San Teodoro salt pan, included cladocerans *Daphnia magna* and *Simocephalus* sp., as well as ostracods and unidentified cyclopoid copepods (F. Marrone, *pers. comm.*).

The open question is what does influence the Spoonbills to explore such “extreme” sites for feeding? It is therefore suggested that Spoonbills, like other predatory water birds (e.g., the Ardeidae),

exploit these extreme sites as the dense concentration of prey, even if small in size (Fasola et al. 1993, Fasola 1994, Fasola & Cardarelli 2014, Kazantzidis & Goutner 2005) make it a convenient feeding site. In fact, Spoonbills have never been observed in this temporary wetland when it has been extensively flooded, thus indicating that the use of such freshwater ponds, and the predation of Branchiopoda, can be strongly opportunistic and linked to water levels. This explanation is also consistent with the substantial number of observations (465 instances) carried out over eight years (from 2013 to 2020) which showed Spoonbills foraging almost exclusively in tidal lagoons (Stagnone di Marsala), saltmarshes, salt pans, and water reservoirs within the province of Trapani (S. Surdo *personal observations*).

These observations clearly highlight the key role of temporary ponds for migratory birds. Wetland birds such as herons, waterfowls and waders, may indeed profit from temporary ponds for feeding on local crustacean assemblages (Fasola 1994, Boros et al. 2006) and for wintering or stepping stone sites (Grillas & Roché 1997, Horvàth et al. 2013, Troia et al. 2016). On the other hand, migratory birds represent important vectors for the long-range dispersal of the resting stages of Branchiopoda's biota (Green et al 2002, Figuerola et al. 2003, Incagnone et al. 2015), thus allowing them to colonize new water catchments.

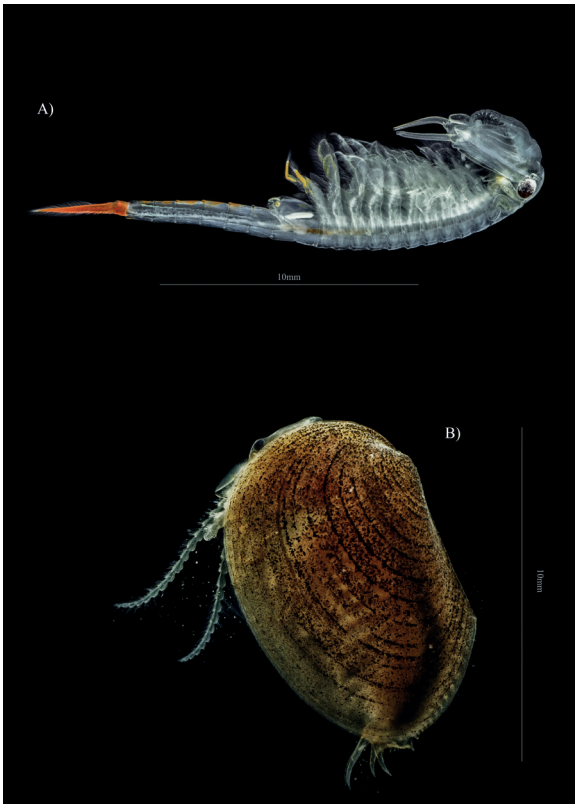


**Figure 1** *Chirocephalus diaphanus* (A) and *Cyzicus tetracerus* (B) sampled on the 27th of February 2017 in a temporary freshwater wetland (Photo by Alessandro Barra).

Although the Ramsar Convention (Ramsar 2002) has recently acknowledged the importance of temporary ponds, political recognition of these wetlands as a crucial part of water environment remains elusive throughout European Union (EU). The Mediterranean Temporary Ponds, like those used by Spoonbills for opportunistic foraging, is a clear example. Although listed as "priority habitats" in the EU "Habitats Directive" (code 3170), the Mediterranean Temporary Ponds are often overlooked and exposed to perturbations and total destruction (Grillas et al. 2004, Schwartz & Jenkins 2000). A various range of anthropogenic activities, such as intense agriculture, land abandonment, fires, overgrazing, introduction of exotic species and climate changes, (Grillas et al. 2004, Zacharias et al. 2007) has resulted in a large percentage of the Mediterranean Temporary Ponds disappearing in recent years (Marrone & Mura 2006, Marrone et al 2006, Naselli Flores & Marrone 2019, Rhazi et al. 2012).

The relevance of temporary water ponds is even more evident under the climate change scenario we are facing; the optimal foraging habitat for wetland birds could disappear, forcing them to look for alternative areas such as the Mediterranean Temporary Ponds that, as our observations clearly indicate, might provide new/alternative food resources. As such, the fragile ecosystem of the wetlands should be preserved and protected against anthropogenic activities. In this regard, we hope that in the near future the temporary water ponds of this work might become a protected natural area.

**Table 1.** Summary of studies analyzing diet of Eurasian spoonbill *Platalea leucorodia*

| Type | Class or Order | Family | Prey* | Based on | Reference |
|---|---|---|---|---|---|
| Fishes | Pleuronectiformes | Pleuronectidae | *Pleuronectes platessa* | Regurgitates | Jouta et al. 2018 |
| | | | *Pleuronectidae* | Isotope tracers | El-Hacen 2014 |
| | | | *Platichthys flesus* | Faecal material | Veen et al. 2012 |
| | | Bothidae | Bothidae | Faecal material | Veen et al. 2012 |
| | | Percidae | Percidae | Isotope tracers | El-Hacen 2014 |
| | | Soleidae | *Solea* sp.*, Microchirus* sp.*, Solea senegalensis,* | Regurgitates, Stomach contents, Faecal material | Aguilera et al. 1996, Veen et al. 2012 |
| | Gobiiformes | Gobiidae | *Pomatoschistus microps; P. minutus* | Regurgitates | Jouta et al. 2018; Enners et al. 2020 |
| | | | *Gobius paganellus* | Faecal material | Veen et al. 2012 |
| | | | Gobiidae | Faecal material, Isotope tracers | Veen et al. 2012, Boileau et al. 2002, El-Hacen 2014 |
| | Gasterosteiformes | Gasterosteidae | *Pungitius pungitius* | Regurgitates, Visual identification, Stomach contents | Jouta et al. 2018; Wetten & Wintermans 1986a, Petrescu 1999 |
| | | | *Gasterosteus aculeatus* | Regurgitates, Visual identification, Isotope tracers | Jouta et al. 2018, Enners et al. 2020, Wetten & Wintermans 1986a, El-Hacen 2014, Boileau et al. 2002 |
| | Osmeriformes | Osmeridae | *Osmerus eperlanus* | Regurgitates | Jouta et al. 2018, Enners et al. 2020 |
| | Cypriniformes | Cyprinidae | *Rutilus rutilus* | Regurgitates | Jouta et al. 2018 |
| | | Cobitidae | *Cobitis* sp. | Stomach contents | Petrescu 1999 |
| | | Cyprinidae | *Rhodeus* sp. | Stomach contents | Petrescu 1999 |
| | | | *Carassius carassius* | Visual identification | Pigniczki 2008 |
| | Cyprinodontiformes | Fundulidae | *Fundulus* sp. | Regurgitates, Stomach contents | Aguilera et al. 1996 |
| | Atheriniformes | Atherinidae | *Atherina boyeri* | Regurgitates, Stomach contents | Aguilera et al. 1996 |
| | | | *Atherina* sp. | Faecal material | Veen et al. 2012 |
| | Batrachoidiformes | Batrachoididae | *Halobatrachus didactylus* | Faecal material | Veen et al. 2012 |
| | Cichliformes | Cichlidae | *Saratherodon melanotheron,* Cichlidae | Faecal material | Veen et al. 2012 |
| | Labriformes | Labridae | Labridae | Faecal material | Veen et al. 2012 |
| | Perciformes | Gerreidae | *Eucinostomus melanopterus* | Faecal material | Veen et al. 2012 |
| | | Moronidae | *Dicentrarchus punctatus* | Faecal material | Veen et al. 2012 |

| | | | | | |
|---|---|---|---|---|---|
| | | Sparidae | *Diplodus sargus,* Sparidae | Faecal material | Veen et al. 2012 |
| | | Polynemidae | *Galeoides decadactylus* | Faecal material | Veen et al. 2012 |
| | | Sciaenidae | *Umbrina* sp. | Faecal material | Veen et al. 2012 |
| | | Percidae | *Perca fluviatilis* | Regurgitates | Jouta et al. 2018 |
| | Mugiliformes | Mugilidae | Mugilidae | Faecal material | Veen et al. 2012 |
| Shrimps | Decapoda | Palaemonidae | Palaemonidae, *Palaemonetes varians* | Regurgitates, Visual identification, Stomach contents; Isotope tracers, Faecal material | Aguilera et al 1996, Boileau et al. 2002, El-Hacen 2014, Veen et al. 2012 |
| | | Crangonidae | *Crangon crangon* | Stomach contents, Regurgitates, Isotope tracers | Tinbergen 1933, Jouta et al. 2018, Enners et al. 2020, El-Hacen 2014 |
| Crabs | | Portunidae | *Carcinus maena* | Regurgitates, stomach contents | Aguilera et al. 1996 |
| Crayfish | | Astacidae | *Astacus leptodactylus* | Stomach contents | Petrescu 1999 |
| | | Cambaridae | *Procambarus clarki* | Regurgitates, Stomach contents | Aguilera et al. 1996 |
| Frogs | Anura | Bombinatoridae | *Bombina bombina* | Visual identification | Kalotás 2003 |
| | | Ranidae | *Pelophylax ridibundus* | Visual identification | Pigniczki 2017 |
| | | | *Rana* sp. | Visual identification | Pigniczki 2008 |
| Reptiles | Squamata | | Squamata | | Cramp & Simmons 1986 |
| Isopods | Isopoda | | Isopoda | Regurgitates, stomach contents | Aguilera et al. 1996 |
| Aquatic Insects | Odonata | | Odonata (dragonflies) | | Cramp & Simmons 1986 |
| | Orthoptera | | Orthoptera (locusts) | | Cramp & Simmons 1986 |
| | Hemiptera | | Hemiptera, *Naucoris* sp. | Regurgitates, stomach contents | Cramp & Simmons 1986 Aguilera et al. 1996, Petrescu 1999 |
| | Coleoptera | Dytiscidae | *Acilius* sp., *Colymbetes* sp. | Regurgitates, Stomach contents | Cramp & Simmons 1986, Aguilera et al. 1996, Petrescu 1999 |
| | Diptera | | Diptera (flies) | | Cramp & Simmons 1986 |
| | Trichoptera | | Trichoptera (caddisflies) | | Cramp & Simmons 1986 |
| Spiders | Arachnida | | Arachnida | Regurgitates, stomach contents | Aguilera et al. 1996 |
| Aquatic Molluscs | Bivalvia | | *Tellina* sp; Bivalvia | Regurgitates, stomach contents | Cramp & Simmons 1986, Aguilera et al. 1996 |
| Snails | Gastropoda | | Gastropoda | Regurgitates, stomach contents | Aguilera et al. 1996 |
| | Littorinimorpha | Hydrobiidae | *Hydrobia ulvae* | Faecal material | Veen et al. 2012 |
| Worms | Errantia | Nereididae | *Nereis* sp. | Faecal material, Regurgitates | Veen et al. 2012, Enners et al. 2020 |

**Acknowledgments**

I thank Federico Marrone for the precious identification of Branchiopoda, Tommaso La Mantia for stimulating discussion and encouragement to publish my observations, Andrea Cusmano who helped during my fieldwork, Alessandro Barra for the captured pictures and Bruno Massa for fruitful suggestions regarding the manuscript shape. I also wish to thank Letizia Campioni (Associate editor), Mauro Fasola (University of Pavia), Stefano Volponi (Istituto Superiore per la Protezione e la Ricerca Ambientale) and an anonymous referee for the critical reading of the manuscript and useful comments.

**REFERENCES**

Aguilera E., Ramo C. & de le Court C., 1996. Food and feeding sites of the Eurasian spoonbill *Platalea leucorodia* in Southwestern Spain. Colon. Waterbirds 19: 159-166. https://doi.org/10.2307/1521960

Altenburg W. & Wymenga E., 1997. Voedsel voor lepelaars. Birdlife. Netherlands, Zeist, pp. 32.

Alonso M., 1996. Crustacea, Branchiopoda. In: Fauna Iberica. M.A. Ramos et al. (ed.). Vol. 7. Museo Nacional de Ciencias Naturales, CSIC, Madrid.

Bagella S., Gascón S., Filigheddu R., Cogoni A. & Boix D., 2016. Mediterranean Temporary Ponds: new challenges from a neglected habitat. Hydrobiologia 782: 1–10. https://doi.org/10.1007/s10750-016-2962-9

Boileau N., Caupenne M. & Le Campion T., 2002. Ecologie alimentaire de la Spatule blanche *Platalea leucorodia* en migration postnuptiale dans le marais de Brouage (Charente-Maitime). Annales de la Société des Sciences Naturelles de Charente-Maritime 9: 205-218.

Boros E., Bánfi Sz. & Forró L., 2006. Anostracans and microcrustaceans as potential food sources of waterbirds on sodic pans of the Hungarian plain. Hydrobiologia 567: 341–349.

Cramp S. & Simmons K.E.L., 1986. Handbook of the birds of Europe, the Middle East and North Africa. Vol. 1. Ostrich to ducks. Oxford University Press, London, NY, pp. 200–207.

El-Hacen E.H.M., Piersma T., Jouta J., Overdijk O. & Lok T., 2014. Seasonal variation in the diet of Spoonbill chicks in the Wadden Sea: a stable isotopes approach. J. Ornithol. 155: 611–619. doi 10.1007/s10336-014-1043-y

Enners L., Guse N., Schwemmer P., Chagas A.L.J., Voigt C. C. & Garthe S., 2020. Foraging ecology and diet of Eurasian spoonbills (*Platalea leucorodia*) in the German Wadden Sea. Estuar. Coast. Shelf Sci. 233: 1-8. doi: 10.1016@j.ecss.2019.106539

Fasola M., Rosa P., Canova L., 1993. Diets of squacco herons, little egrets, night, purple and grey herons, in their Italian breeding range. Terre Vie 48: 35–47.

Fasola M., 1994. Opportunistic use of foraging resources by heron communities in southern Europe. Ecography 17: 113–123. https://doi.org/10.1111/j.1600-0587.1994.tb00083.x

Fasola M. & Cardarelli E., 2015. Long-term changes in the food resources of a guild of breeding Ardeinae (Aves) in Italy, Ital. J. Zool. 82: 238-250. doi: 10.1080/11250003.2014.966256

Figuerola, J., Green, A.J., & Santamaria, L., 2003. Passive internal transport of aquatic organisms by waterfowl in Doñana, south-west Spain. Glob. Ecol. Biogeogr. 12: 427–436.

Green A.J., Figuerola J & Sánchez M. I., 2002. Implications of waterbird ecology for the dispersal of aquatic organisms. Acta Oecologica 23: 177–189.

Grillas P. & Roché J. 1997. Vegetation of temporary marshes, ecology and management. Conservation of Mediterranean Wetlands. Med Wet. Station Biologique de la Tour du Valat, Arles.

Grillas P., Gauthier P., Yaverkovski N. & Perennou C., 2004. Mediterranean Temporary Pools 1. Station Biologique de la Tour du Valat, Arles.

Horváth, Z., Vad, C.F., Vörös, L. & Boros, E., 2013. The keystone role of anostracans and copepods in European soda pans during the spring migration of waterbirds. Freshw. Biol. 58: 430-440. doi:10.1111/fwb.12071

Ientile R., Surdo S. & Iapichino C., 2020. The Eurasian Spoonbill *Platalea leucorodia* in Sicily between 1972 and 2018, distribution and ecology pp. 339-347. In: La Mantia T., Badalamenti E., Carapezza A., Lo Cascio P. & Troia A. (ed.), Life on islands. Biodiversity in Sicily and surrounding islands. Studies dedicated to Bruno Massa. Danaus, Palermo.

Incagnone G., Marrone F., Barone R., Robba L. & Naselli Flores L., 2015. How do freshwater organisms cross the "dry ocean"? A review on passive dispersal and colonization processes with a special focus on temporary ponds. Hydrobiologia 750: 103–123. https://doi.org/10.1007/s10750-014-2110-3

Jouta J., de Goeij P., Lok T., Velilla E., Vamphuysen C.J., Leopold M., van der Veer H.W., Olff H., Overdijk O. & Piersma T., 2018. Unexpected dietary preferences of Eurasian Spoonbills in the Dutch Wadden Sea: spoonbills mainly feed on small fish not shrimp. J. Ornithol. 159: 839–849. https://doi.org/10.1007/s10336-018-1551-2

Kalotás Z., 2003. Spoonbill (*Platalea leucorodia*) feeding on Fire-bellied Toad (*Bombina bombina*). Aquila 109-110: 173-174.

Kazantzidis S. & Goutner V., 2005. The diet of nestlings of three Ardeidae species (Aves, Ciconiiformes) in the Axios Delta, Greece. Belg. J. Zool. 135: 165-170.

Kemper J.H., 1986a. Foraging strategy in the spoonbill, *Platalea leucorodia*. Report 33. Instituut voor Taxonomische Zoölogie, Amsterdam.

Kemper J.H., 1986b. Voedselbeperking voor de lepelaar van hetzwanenwater. Lev. Nat. 87: 66–71.

Marrone F. & Mura G., 2006. Updated status of Anostraca, Notostraca and Spinicaudata (Crustacea Branchiopoda) in Sicily (Italy): review and new records. Naturalista sicil. 30: 3-19.

Marrone F., Barone R. & Naselli Flores L., 2006. Ecological characterization and cladocerans, calanoid copepods and large branchiopods of temporary ponds in a Mediterranean island (Sicily, southern Italy). Chemistry and Ecology 22: sup1 S181-S190. doi: 10.1080/02757540600557827

Naselli-Flores L. & Marrone F., 2019. Different invasibility of permanent and temporary waterbodies in a semiarid Mediterranean Island. Inland Waters 9: 411-421. doi: 10.1080/20442041.2019.1653110

Petrescu A., 1999. Food of some herons, Glossy Ibis and Spoonbill (Aves: Ardeidae and Threskiornithidae) in south-eastern Romania. Travaux du Museum National d'Histoire Naturelle 'Grigore Antipa' 41: 393-414.

Pigniczki C., 2008. Grey Heron (*Ardea cinerea*) and Great Egret (*Ardea alba*) pillaging frogs (*Rana* sp.) and Crucian carp (*Carassius carassius*) from Eurasian Spoonbills (*Platalea leucorodia*). Aquila 114-115: 178-179.

Pigniczki C., 2017. Unique Prey Handling of Eurasian Spoonbill (*Platalea leucorodia*). Waterbirds 40: 74-76. https://doi.org/10.1675/063.040.0111

Rhazi L., Grillas P., Saber E.-R., Rhazi M., Brendonck L. & Waterkeyn A., 2012. Vegetation of Mediterranean temporary pools: a fading jewel? Hydrobiologia 689: 23–36.

Schwartz S. S. & Jenkins D. G., 2000. Temporary aquatic habitats: constraints and opportunities. Aquat. Ecol. 34: 3–8.

Tinbergen L., 1933. Lepelaarmaag. Lev. Nat. 38: 262.

Troia A., Adragna F., Campisi P., Dia M. G., Ilardi V., La Mantia T., La Rosa A., Lo Valvo M., Muscarella C., Pasta S., Pieri V., Scuderi L., Sparacio I., Stoch F. & Marrone F., 2016. I pantani di Anguillara (Calatafimi Segesta, Trapani): dati preliminari sulla biodiversità a supporto della tutela del biotopo. Naturalista sicil. 40: 171-200.

van Wetten J.C.J. & Wintermans G.J.M., 1986a. The Food Ecology of the Spoonbill *Platalea leucorodia* 49. Inst. Tax. Zool., Univ. Amsterdam, pp. 63.

van Wetten J.C.J. & Wintermans G.J.M., 1986b. Voedselecologie van de lepelaars van het Zwanenwater en Texel. Graspieper 6: 96–109.

Veen J., Overdijk O. & Veen T., 2012. The diet of an endemic subspecies of the Eurasian Spoonbill *Platalea leucorodia balsaci*, breeding at the Banc d'Arguin, Mauritania. Ardea 100: 123–130.

Wintermans G.J.M. & Wymenga E., 1996. Voedsel voor lepelaars; knelpunten, oplossingsrichtingen en aanbevelingen voor de inrichting en het beheer van voedselgebieden van Lepelaars. Altenburg &Wymenga Ecological Research and Consultancy.

Zacharias I., Dimitriou E., Dekker A. & Dorsman E., 2007. Overview of temporary ponds in the Mediterranean region: threats, management and conservation issues. J. Environ. Biol. 28: 1–9.

Zenatello M., Baccetti N. & Borghesi F., 2014. Risultati dei censimenti degli uccelli acquatici svernanti in Italia. Distribuzione, stima e trend delle popolazioni nel 2001-2010. ISPRA, Serie Rapporti, 206.



Received: 5 June 2020
First response: 24 July 2020
Final acceptance: 30 September 2020
Published online: 19 October 2020
Associate editor: Letizia Campioni