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Seasonal pools in the vegetation of Gavdos (Greece) - *in situ* conservation required

Abstract

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Flora, vegetation, and inundation regime of rock pools on Gavdos, the southernmost European island, are described in detail. Requirements for nature conservation are also addressed. The seasonally water-filled cavities provide habitat for several rare species, including *Callitriche pulchra*, and *Matricaria aurea* with their single Greek localities in the island. Five plant communities may be distinguished along an ecological gradient of decreasing water level and inundation period.

Introduction

Gavdos (32 km^2) is the southernmost European island (34°48-52'N 24°02-08'E). Although geographically (37 km) close to western Crete, it shows important differences in floristics and vegetation. The vascular flora consists of some 460 taxa, c. 30 (6 %) of which do not occur in western Crete but are chiefly south Mediterranean/north African species at their northern border of distribution (Bergmeier & al. 1997).

Mean annual precipitation in Gavdos is less than 400 mm. Geological formations include tertiary sediments with sandy soils in the northeast, crystalline limestone in the southwest, and minor ares with flysch and ophiolithic substrata (Vicente 1970). Gavdos inhabitants have decreased to less than 50 to date but summer tourism is esxpanding. Extensive grazing by goats and sheep occurs throughout the island.

Most remarkable among the unique features of the island are small karstic rock pools and depressions seasonally filled with rain water which were already noticed as important plant habitats by Dörfler when collecting on the island in 1904 (Vierhapper & Rechinger 1935). Recent field studies revealed several rare and ecologically specialised species and plant communities. The present paper highlights the flora, vegetation, and the flooding regime of such seasonal pools which are poorly represented in Crete but so well in Gavdos.

Methods

Seasonal pools were found scattered in various parts of the island, on exposed rock (Fig. 1). Relevés were taken in all available sites using standard Braun-Blanquet approach sampling technique (e.g., Dierschke 1995). Plot size was 50 ×50 cm. For each relevé at least the following data were sampled: species composition; cover/abundance values; pool depth; water level; substrate; adjacent vegetation; locality. Sampling time was in 1995 and 1996, in April/May.

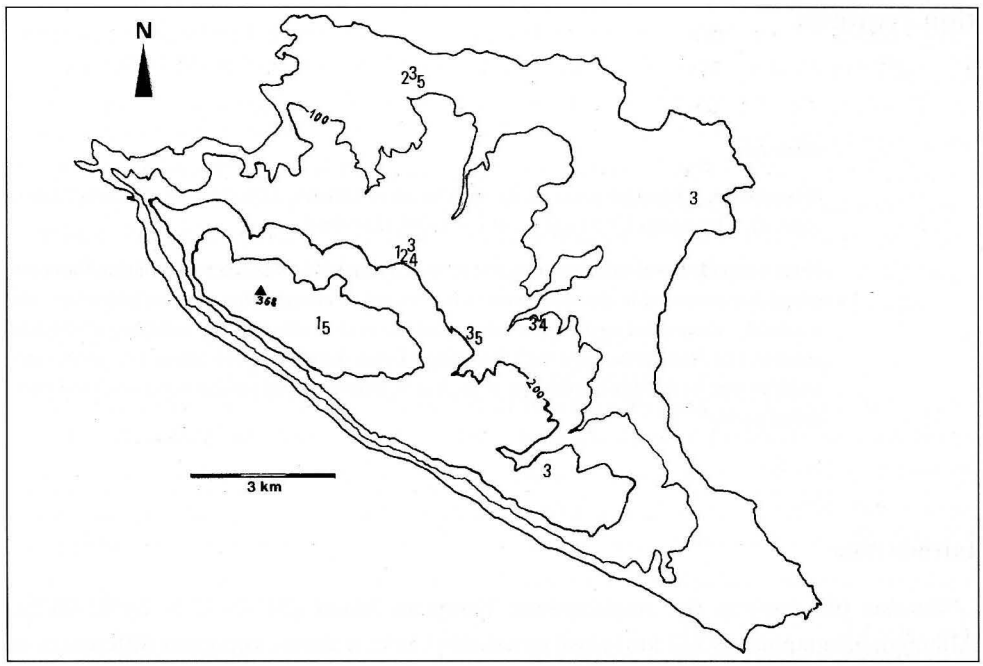

Fig. 1. Distribution of plant communities of rock pools in Gavdos. - 1, *Zannichellia-Callitriche pulcra* community; 2, *Callitritriche-Tillaea vaillantii* community; 3, *Tillaea vaillantii* community; 4, *Tillaea vaillantii-Poligonon maritimus* community; 5, *Tillaea alata-Crepis pusilla* community.

Results and discussion

Pool vegetation was found in shallow depressions and somewhat deeper cavities in limestone and ophiolithic rock. The size of the pools rarely exceeds one square metre, and their depth is generally less than 50 cm. There is but a thin layer of deposits on the ground. The depressions are filled with rain water during winter and early spring but all are dry from late May until rainy season begins in late autumn. Most remarkable among the taxa found in such habitats are:

- *Callitriche pulchra* Schotsman (single European locality, otherwise only in NE Libya);
- *Matricaria aurea* (L.) C. H. Schultz (single Greek locality, otherwise widespread but local);

- *Phleum crypsoides* (D'Urv.) Franchet subsp. *crypsoides* (rare Aegean endemic);
- *Tillaea vaillantii* Willd.;
- *Tillaea alata* Viv.;
- *Crepis pusilla* (Somm.) Merxm. (the latter three widespread in the Mediterranean but rare and local).

Callitriche pulchra has been included in the Red-Data Book of rare and threatened plants of Greece (Turland in Phitos & al. 1996). On a national scale, the single known Greek population of *Matricaria aurea* which was found during the present study (Bergmeier & al. 1997) is likewise endangered.

Differences in species composition between and within the pools suggest differentiation of five plant communities all of which were hitherto unknown from Greece (Table 1):

1. *Zannichellia-Callitriche pulchra* community [Zannichellion pedicellatae, Potamogetonetea];
2. *Callitriche pulchra-Tillaea vaillantii* community [intermediate between 1 and 3];
3. *Tillaea vaillantii* community [Isoetion, Isoeto-Nanojuncetea];
4. *Tillaea vaillantii-Polypogon maritimus* community [Intermediate between 3 and 5];
5. *Tillaea alata-Crepis pusilla* community [Plantagini-Catapodion marini, Thero-Brachypodietea].

Table 1. Synoptic table of plant communities of seasonal pools in the island of Gavdos. Columns contain presence values (in % of the total number of relevés per column). Taxa in 1 or 2 relevés only have been omitted.

Number of syntaxon*	**1**	**2**	**3**	**4**	**5**
Number of relevés	5	2	10	5	9
Zannichellia pedunculata Reichenb.	100	50	.	.	.
Callitriche pulchra Schotsman	60	50	.	.	.
Chara vulgaris L.	40	50	10	.	.
Tillaea vaillantii Willd.	.	100	100	100	.
Lythrum hyssopifolia L.	.	.	60	60	11
Polypogon maritimus Willd.	.	.	10	100	.
Juncus hybridus Brot.	.	.	20	80	44
Poa infirma Kunth	.	.	10	60	22
Sagina maritima G. Don	.	.	20	60	78
Plantago weldenii Reichenb.	.	.	.	80	78
Matricaria aurea (L.) Schultz Bip.	.	.	.	60	.
Anagallis arvensis L.	.	.	.	40	11
Trifolium suffocatum L.	.	.	.	20	89
Tillaea alata Viv.	.	.	.	20	100
Bupleurum semicompositum L.	.	.	.	.	44
Crepis pusilla (Somm.) Merxm.	.	.	.	.	56
Filago cretensis Gand.	.	.	.	.	56
Polycarpon tetraphyllum (L.) L.	.	.	.	.	56
Erophila praecox (Steven) DC.	.	.	.	.	56
Phleum crypsoides (D'Urv.) Franchet	.	.	.	.	56
Sedum litoreum Guss.	.	.	.	.	44
Galium murale (L.) All.	.	.	.	.	33
Erodium cicutarium (L.) L'Hér. subsp. ***Bipinnatum*** (Cav.) Tourlet	.	.	.	.	33

There is a clear relationship between pool depth/size and inundation period which, in turn, is reflected by vegetation pattern (Fig. 2). Shallow depressions which dry up already in February form the habitat of a *Tillaea alata-Crepis pusilla* community while *Zannichellia pedunculata*, *Callitriche pulchra* and *Chara vulgaris* occur exclusively in

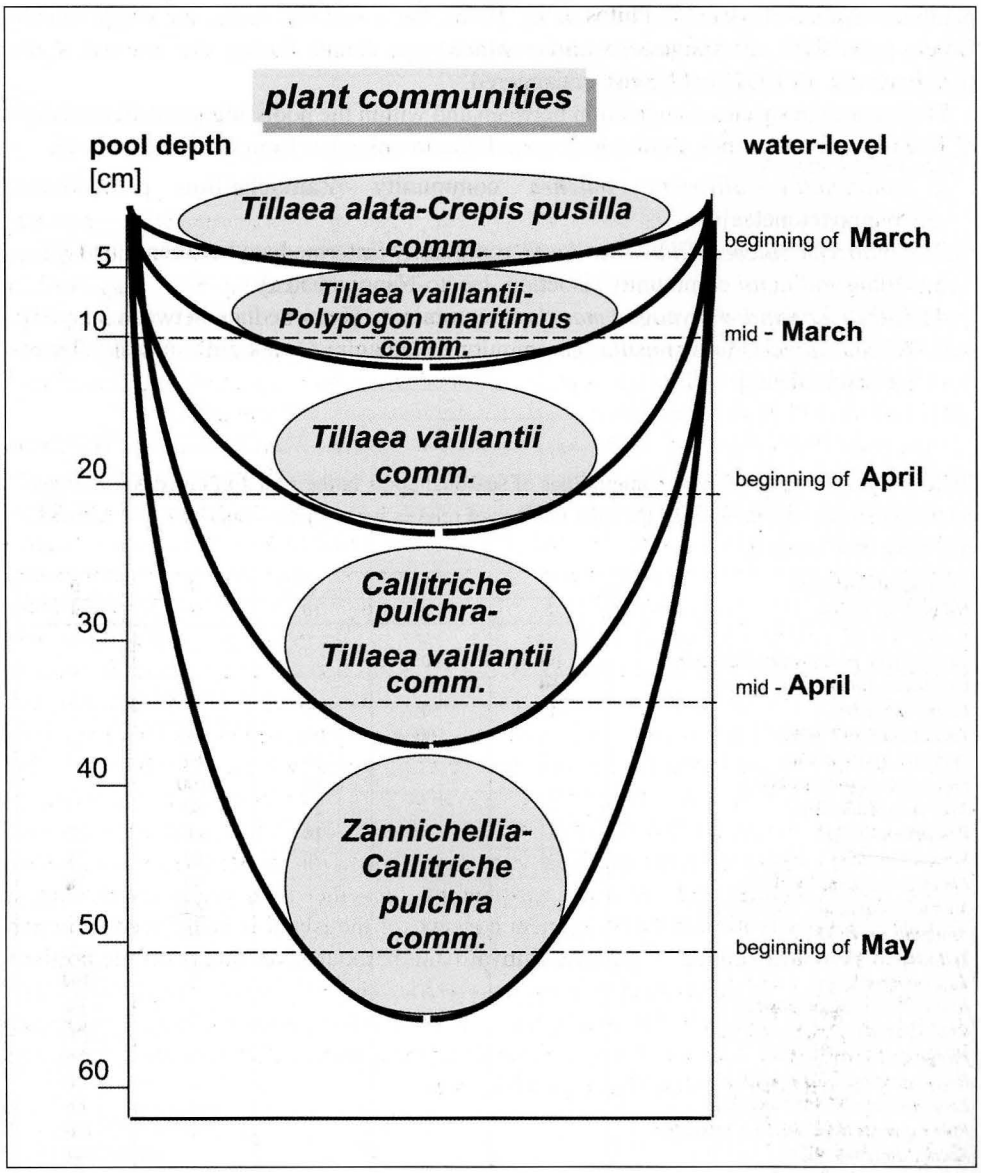

Fig. 2. Relations between pool depth, seasonal water-level, and vegetation type, in rock pools of Gavdos.

deeper large cavities which store water until May. The other communities were found in rock pools of moderate depth or margins of deeper ones. Fairly deep pools with gradually sloped margins show a characteristic zonation of vegetation along with the ecological gradient (decreasing water level during springtime).

1 *Zannichellia-Callitriche* community;
2 *Callitriche-Tillaea vaillantii* community;
3 *Tillaea vaillantii* community;
4 *Tillaea* vaillantii-Polypogon maritimus community;
5 *Tillaea alata-Crepis pusilla* community.

Concluding remarks

Rock pools on Gavdos prove to be significant for rare plants and vegetation – and they offer important feeding and watering habitats for birds resting on Gavdos during their long-distance flights from North Africa across the sea. Migrating birds may well be responsible for the distribution of e.g., the Cyrenaica-Gavdos endemic *Callitriche pulchra*. The latter species was already found more than 90 years ago by I. Dörfler in what was most probably the same site than at present. This fact suggests potential longevity of rock pool habitats although vegetation consists chiefly of short-lived annuals.

Turland (1996) proposed, as precognition of any conservation measure, to search for *Callitriche* populations and localities in Gavdos.The present study provides such data and also details on the habitat of *Callitriche* and ecologically related species on the island (not "marshy pools" as was stated by Turland (1996)). Rain water rock pools are neither numerous nor prominent or extensive in the landscape of Gavdos, and, therefore, the ecosystems may easily be destroyed accidentally. So far there was apparently little danger since many pools serve traditionally as seasonal watering-places for sheep and goats. Small but deep cavities have temporarily been covered by flat stones to prevent evaporation. In order to increase water storage some pools had been somewhat excavated in former times, and excessive sedimentation is prevented. In these years, however, road constructing and building activities on the island for touristic and other purposes will increase the risk of by-chance destruction. *Ex situ* conservation for *Callitriche pulcra* and other species would be important to minimise the risk of extinction. However, more than just genetic preservation is needed for safeguarding the special habitat and vulnerable ecosystem. *In situ* conservation of both localities and the wider surroundings, together with yearly monitoring, is required! A conservation and development concept for the island is badly needed, in particular in view of planning of gigantic shipyard and harbour investments off the northern coast of Gavdos which have recently come to public. This will affect, though hardly predictable in detail, not only the coastal ecosystems but also inland habitats, by changing land-use conditions. The rock pools, and in fact the total island of Gavdos, are by no means a negligible part of the natural heritage of Greece.

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