

## Ecomorphological Study of *Primula verticillata* from Tanumah Waterfall

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**ABSTRACT.** Tanumah site located in the highland of Asir Mountains (110 km from Abha), with rainfall throughout the year specially in spring and summer. As species *Primula* was found dominant and growing at different altitude within the waterfall zone in this area, a detail description of the morphology of this species in relation to the ecology of the site was investigated.

During this study a type of mosses and Pteridophyta species was recorded with some of higher plants. The significant variations in the morphology of *Primula* species upper and lower the waterfall zone encourage us to study this phenomena in relation to other factors might affect this observation.

Regarding the morphological study, the data shows that *primula* growing at site I (low altitude) shows high morphological measurement compared with that of site II (high altitude). This may refer to the high concentration of elements precipitated as a tufa-deposition at site I in addition to high opportunity of cross-pollination, which gives rise to healthy plants with good growth. This in contrast to that found at site II, where low concentration of elements (calcareous soil) and low possibility of cross pollination, which might effect the growth morphology and seeds set of the upper site species.

In addition to that factor mentioned, it was found that there is a role of *Macroglossum* insect in cross pollination which found active during winter period which consequently increases the efficiency of pollination and consequently increases fertility and seed production of the species.

### **Introduction**

To our knowledge a very few studies have been carried out on the vegetation of Tunuma area (Asir Mountains) in Southwestern Saudi Arabia. The area due to its ecology and climate shows a rich vegetation with high number of endemic

plants<sup>[1]</sup> and even for lower plants shows a high number of bryophytes in the rainfall and wet area<sup>[2,3]</sup>.

No doubt that the isolation and the high altitude of this area somehow shows different ecological system compared to other ecosystems in Saudi Arabia. This probably plays an important role in representing such specific vegetation and many of endemic species. This attracts our attention to investigate the biology of one of the most abundant species in this area *Primula verticillata* in relation to its adverse ecological system, where the species has specific importance in the taxonomy of family primulaceae and the evolution of species within this genus<sup>[4]</sup>.

## Material and Methods

### *Ecology of the area*

The mean maximum and minimum temperature and annual rainfall throughout the year were recorded referred to Vesey-Fitzgerald<sup>[5]</sup> and Ministry of Agriculture in Saudi Arabia<sup>[6]</sup>. Soil structure, habit and geology of the area were also described as well as water system based on Al Shehri<sup>[3]</sup>. Water chemistry and pH values of all sites in the area were also estimated using methods given by American Public Health Association<sup>[7]</sup>.

### *Morphological and breeding studies*

Fresh materials of *Primula verticillata* specimens were collected from natural populations in Southwest Saudi Arabia (Tanumah region). About 50 specimens were collected to be studied. Fine description of the species was recorded based on replicate measurements of all characters of the species as well as the time of vegetation, flowering and pollination. The specimens were gathered from two main sites in the waterfall depends upon the highest from the water level of the pool (Site I from 1-5 and site II from 15-25 m).

Fully open flowers were collected and fixed in 70% ethanol to insure the amount of disturbance to the pollen deposited in the stigma. Flowers were carefully measured for corolla tube length, corolla limb diameter and herkogamy in mm. Pollen grains number was also counted.

Number of pollen on stigma was estimated. Seed set was also estimated from single capsule for each plant from the two sites.

## Results and Discussion

### *Location*

Tanumah (Al Dahna) (18°58' North, 42°06' East) is (c. 1920 m above sea level) located on the highlands of Asir Mountains, southwest Saudi Arabia. It is

about 110 km north of Abha about (600 m (from Taif-Abha main road (Fig. 1). Although it is located in the highland region, the Tanumah site is lower than its surroundings.

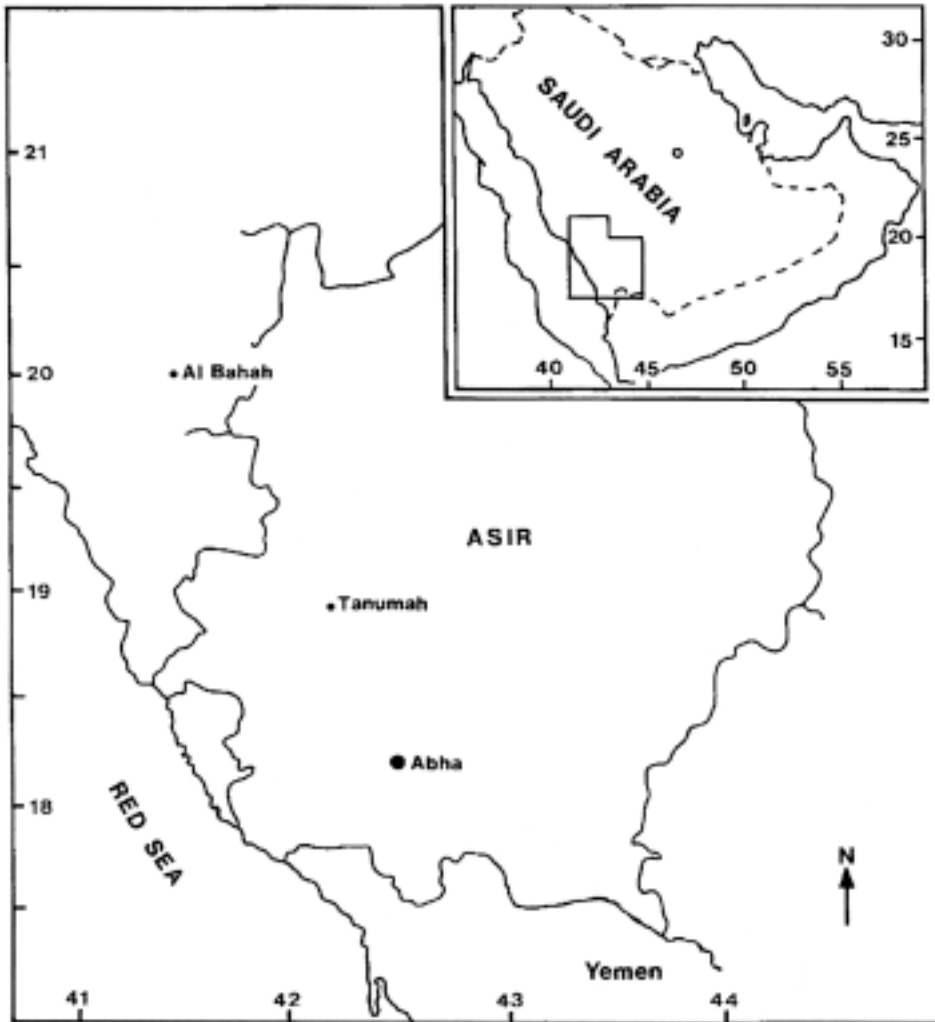


FIG. 1. Location of Tanumah (Site of Study).

## *Climate*

### *Temperature*

The mean maximum and minimum temperatures are 27.6°C and 5.6°C respectively, while the mean temperature is about 17.3°C<sup>[6]</sup>.

### *Rainfall*

The mean annual rainfall recorded in 1986 was 221 mm<sup>[6]</sup>. The rain falls throughout the year, but especially in spring and summer. However according to Vesey-Fitzgerald<sup>[5]</sup>, there are three notable rainy seasons: 1. Monsoon (from August to mid-October). 2. Cyclonic winter (around December). 3. Early summer (around May). These three types of rain can be light, erratic or may fall altogether over a period of years, but the monsoon rain seems most reliable for the Tanumah area.

### *Site description*

Al-Dahna twin waterfalls are sites (Fig. 2a) of tufa-deposits and are about 60-65 m high tall. At the tufa-deposition, *Primula verticillata* was found growing at different altitude within the waterfall zone. The tufadeposition (Fig. 2b) is wider at the bottom (4-5 m) than at the top (1-2 m).



FIG. 2a.



FIG. 2b.

Cliffs surround the waterfalls from east to west and they face northwest. The quantity of water over the falls at a given time is controlled by the dam, which lies about 370 m away from the summit of the waterfalls. The waterfalls drop directly into a lake. The lake is about 30 m long, 20 m wide and 10 m deep. The vegetation of the waterfall is dominated by the moss *Hydrogonium fontanum* (C. Mull). Jaeg. Pteridophyta species and higher plants such as *Primula verticillata* were found growing within the waterfall zone.

Water chemistry analysis at sites is shown in Table 1. The pH value at all three sites were above 7.0 and below 8.0.

TABLE 1. Chemistry of water at 3 sites in Tanumah (Al-Dahna) waterfall, element concentration recorded as mg l<sup>-1</sup> TDS = Total Dissolved Salt and Ono-detectable (ND).

	Site		
	Waterfall	Lake	Al-Dahna Dam
pH	7.72	7.48	7.72
Cond. (Us cm <sup>-1</sup> )	449.	474.	483.
Tot. alk. (meq l <sup>-1</sup> )	3.2	2.9	2.9
Na	44.	44.	41.
K	0.8	1.6	1.2
Mg	15.	16.	17.
Ca	44.	58.	38.
Cl	60.	60.	50.
SO <sub>4</sub>	14.81	9.81	11.52
TDS	264.	244.	214.

### **Morphology**

*Primula verticillata* is a stout glabrous farinose or nearly efarinose, perennial with a stout more less branched rhizome covered with the withered bases of old petioles. Leaves are usually gray-green, lacking hairs. Leaf length of site 1(1-5 m high) recorded 39.5 cm mean value, width 8.5 cm, while the site 11(15-25 m) samples recorded a value of 21.7 cm and 3.5 cm for the same measurements respectively. Oblong to oblanceolate, leaf apex length .1.9-2 cm mean 0.5 cm, tapering into the petiole. Length to start of teeth is 28 cm for site I and 14.2 for site II; with length of toothed part 13.5 and 4.9 cm, irregularly serrate to biserrate at margin, the teeth often with 1 or 2 smaller ones at their base, number of lateral primary veins 4-8, number of secondary veins 12-30, leaf-surface reticulation close, conspicuous above, prominent below. Stems bearing up to 4 whorls each bearing up to 18 golden yellow flowers. Length of corolla tube 21-39 mm, narrowly cylindrical, ampliate at insertion of the stamens. Style length 22-38 mm; height of anther 19-35 mm, both anther and stigma near the throat of the corolla tube (homostyle), but some styles of varying length. Calyx length 7-13 mm, width 5-11 mm, campanulate-shaped, corolla yellow, limb length 4-11 mm, width 3-8 mm for site II and I respectively. Capsule globose, dehiscent 4-5 values. The prolate-colporoidate pollen is the largest in this group (mean diameter 26 µm).

As the data of the two sites are significantly different, this may refer to the pollination condition of the two sites where plants of site I have opportunity of good and perfect pollination either by carrying pollen from plants of upper side through waterfall or by fall down of pollen by gravity in addition to the presence of insect pollinator as *Macroglossum stellatarum*. This is in contrast to the upper site (II), where plants have low opportunity of pollination condition. This is in addition to ecological characters of soil at site I, where it is clay soil in nature and it could be rich in minerals compared to the calcareous soil at site II. No doubt that good pollination achieved for plants at site I leads to high percentage of fertilization and consequently form high number of seed per capsule rather than plants of site II.

This investigation has revealed some unexpected features of the population structure and pollen flow patterns of *Primula verticillata*. Corolla tube is of mean value 32.6 mm, and lengths vary significantly between individuals in the population for the two sites.

Flower description of this homostylous (monomorphic) species, the stigma and anthers are usually positioned close together at the mouth of the flower, on average showing a small approach herkogamy. However, when the style lengths and anther positions are calculated as a proportion of the corolla tube length, it is clear that considerable variation for herkogamy occurs between individuals in the population. In the sample examined, the variation in pollen grains number on the stigma surface occurred at three levels: a) flowers with zero herkogamy showed large numbers of pollen grains, the average being more than 500 grains. b) flowers with approach herkogamy had gathered a few pollen grains. c) flowers with reverse herkogamy had gathered very few pollen grains. Thus, in sample, a highly significant negative relationship occurred between herkogamy against pollen grain number on the stigma, which consequently might affect seed set. Not surprisingly seed set and stigmatic pollen loads were not related between plants as stated by Al Wadi and Richards<sup>[1]</sup>.

*P. verticillata* has a very long, narrow flower tube, and it is likely that flower visitors are restricted to long-tongued mouths, especially sphingids.

In the absence of such specialist pollinators, we would expect herkogamy and seed set to be negatively correlated, as most pollination would depend on selfing. However, if specialist long-tongued pollinators (e.g. *Macroglossum stellatarum*) are active, we might find that more pollination occurs on herkogamous flowers (especially those with an exerted stigma). However, we have no direct evidence of pollination by *Macroglossum*.

Thus, it is possible that *Macroglossum*, if this is indeed the pollinator, was more active in the winter than in the early spring, and sometime weather in the

Asir is bad (with mist, rain, and temperatures 5-10°C) and pollinator activity would have been very low.

In Palestine, Arroyo and Dafni<sup>[8]</sup> show that *Macroglossum* (presumably overwintering migrant adults) is common in January and February. This is also a common animal in Saudi Arabia, and it is likely that during fine weather, it would be active on *P. verticillata* in January. However, we have no evidence to this effect.

Finally it could be concluded that differences in weather, ecology and in specialist pollinator activity, seem to be the possible explanation for the variation recorded between the two sites for all parameters studies.

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## دراسة بيئية مورفولوجية لنبات برميولا فرتيسيلاتا من شلال تنومة

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المستخلص. تقع منطقة تنومة في المنطقة العليا لجبال عسير على بعد ١١٠ كم من مدينة أبها ، وتتميز بالأمطار على مدار السنة وخاصة في الربيع والصيف ، يسود نوع نبات برميولا في هذه المنطقة وينمو على ارتفاعات متفاوتة داخل المصب الموجود في المنطقة ، أجريت دراسة تفصيلية على الشكل الظاهري لهذا النوع وعلاقته مع البيئة الموجود فيها .

أثناء الدراسة سجلت بعض أنواع النباتات التريديية مع بعض النباتات الراقية . بالنسبة لنوع برميولا مجال الدراسة وجدت فروقاً ملحوظة في قياسات الشكل الظاهري بين أعلى المصب وأسفله مما شجع على دراسة الظاهرة وسبب وجود هذا الاختلاف والعوامل المؤثرة عليه .

قسمت منطقة الدراسة إلى منطقتين منطقة رقم (١) أسفل المصب والمنطقة (٢) أعلى المصب كل منها بارتفاع مختلف وكانت قياسات الشكل المورفولوجي لهذا النوع كبيرة في المنطقة (١) بالمقارنة إلى المنطقة (٢) وهذا يرجع إلى التركيز العالي للعناصر التي تترسب أسفل المصب نتيجة لتيار الماء هذا بالإضافة إلى الاحتمال الكبير للتلقيح الخلطي والتي تؤدي إلى وجود نباتات أكثر قوة ونموً وهذا يكون على النقيض لنباتات المنطقة العليا حيث العناصر قليلة والتلقيح الخلطي ضعيف .

بالإضافة إلى العوامل المذكورة سابقاً وجد أنه قد يكون هناك دور هام لنوع حشرة ماكروجلوسم في إتمام التلقيح الخلطي بكفاءة في المنطقة السفلى وهذه الحشرة تكون نشطة في فصل الشتاء ويؤدي ذلك إلى زيادة كفاءة التلقيح وإنتاج البذور للأجيال التالية وزيادة المجموع الخضري في المنطقة السفلى .