Journal of Applied Biology & Biotechnology Vol. 4 (05), pp. 057-062, Sep-Oct, 2016
Available online at http://www.jabonline.in
DOI: 10.7324/JABB.2016.40509

Environmental Impacts of Industrial Pollution on Pollen Morphology of *Eucalyptus globulus* Labill. (Myrtaceae)

Mohamed Azzazy

Environmental Studies and Research Institute, Sadat City University, Egypt.

ARTICLE INFO

Article history:
Received on: 06/06/2016
Revised on: 19/07/2016
Accepted on: 26/08/2016
Available online: 23/10/2016

Key words:
Myrtaceae, Eucalyptus, Pollen morphology, Pollen Ultra structure, Industrial pollution.

ABSTRACT

Study was aimed to investigate the effect of industrial air pollution on pollen morphology of Eucalyptus globulus Labill., belonging to family Myrtaceae. Data revealed that there are differences in pollen morphological characteristics of *E. globulus* that grows in polluted industrial area in comparing with the pollen of that plant grows in healthy conditions (control area). Eucalyptus pollen grains are flattened triangular- obtuse- convex shape in polar view (the only view that is usually present). Aperture (trizonocolpate- syncolpate), colpi fusing in each apocolpium to cut off an island of exine shaped like a triangle. Sculpture, psilate. The LM and SEM studies revealed that pollen grains of the control area showed normal size, shape and sculpture. While in case of polluted industrial one there is a shrinkage in size, thinning of exine, protrusion elements on the pollen surface, some attached particulate materials on the pollen surface; that may be affected due to air pollution.

1. INTRODUCTION

Rapid industrialization causing health hazards, the effect of industrialization on human health, vegetation and on the atmosphere is of great concern in the world today. Various types of diseases, mainly respiratory, are common in industrial towns due to air pollution [1]. Pollution is one of the major problems of different cities in the world. The pollution may be due to human activities or natural ecosystems, natural sources (Volcanoes, Earthquakes); man-made sources (Industrial and transportation). While, in new estimates released today, WHO reports that in around 7 million people died as a result of air pollution exposure. This finding more than double previous estimates and confirms that air pollution is now the world's largest single environmental health risk [2]. Several studies of the effect of air pollution on pollen showed changes such as shrinkage, fragility and thinning [3]. While airborne pollen can be affected directly by air pollutants. If the plant grows in polluted soil, its physiological functions may change and affect the properties of the developing pollen grains [4]. Morphological studies of the pollen grains are very important. While Morphology of pollen is involved in solving some taxonomic problems on the family, generic or specific level and has become part of the multidisciplinary and collaborative approach in plant systematic and evolution [5], also it is valuable and applicable in tracing the history of vegetation of individual species and community, genetic study, forensic science individual species, community and climate change study [6]. Several studies have been published on pollen morphology of some dicots families from various parts of the world. Anacardiaceae, Bignoniaceae, Caricaceae, Myrtaceae, Moringaceae, Meliaceae, Rhamnaceae and Zygophyllaceae [7]. *Eucalyptus globulus*, the Tasmanian blue gum, is an evergreen tree, one of the most widely cultivated trees native to Australia [8]. A large plant, not exactly defined, but typically over four meters in height, a single trunk which grows in girth with age and branches. Eucalyptus or myrtles are a large group of evergreen trees and shrubs grow in tropical areas of the U.S. They can reach over 100 feet in height. Eucalyptus leaves are giving off a pleasant and distinct fragrance. Flowers are primarily insect-pollinated with some wind-pollination. *Eucalyptus globulus* Labill. (Myrtaceae) is one of the world's most widespread hardwood trees. Due to its social, economical and environmental impacts, *Eucalyptus globulus* has been the object of several genetic, ecological and physiological studies. Pollen grains are usually 20-24 micrometers.

** Corresponding Author*
Mohamed Azzazy, Associate professor (Environmental studies and Research institute- Surveys of Natural Resources Dep- Sadat City University, Egypt.

The main aim of this study we try to investigate the effect of industrial air pollution on pollen morphology of *Eucalyptus globulus* Labill., using Light Microscopy (LM) and Scanning Electron Microscopy (SEM) studies.

2. STUDY AREA

Sadat City is one of the new communities, which was established in the early eighties, applying with the governmental strategy of population redistribution. El- Sadat City belongs administratively to Menufiya governorate, within the western Nile Delta region. It is located north of Cairo –Alexandria desert road between Km 95and Km103 from Cairo Fig.1. The City is bounded by longitudinal 30° 19’ 30” -30° 40’ 27” E and latitude 30° 15’ 50” – 30° 34’ 00”N. It is bounded from the East by Kafer Dawoud and El Khatataba, from west by El Birigat, and from north by Nubariya canal and El Tahrir [9].

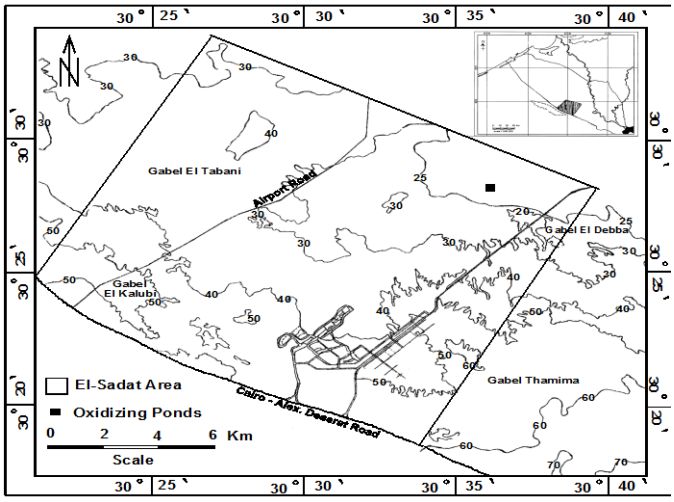

Fig. 1: Topographic map of Sadat City .[18]

Industrial zones are located on a separated spine along the south–eastern edge of the city to ensure industry pollution being downwind. To protect the city against wind and storms, a green shelterbelt about 35000 feddans are planted round the city and two thousand feddans were planted with vegetables and fruits.

3. MATERIALS AND METHODS

3.1 General meteorological data of the study area

Average values of climatic parameters of Sadat City (2004 – 2014) obtained from the Tahrir Meteorological Station, Egypt [10].

3.2 Collection of plant materials

Eucalyptus globules Labill. flowers were collected from the trees growing at the industrial zone and from trees growing at clean un polluted one at Sadat University farm during March–2016 (Figs. 2 and 3), stored in 70% alcohol. Herbarium specimens of the studied plants Voucher specimens (H205 and 206) are deposited at the Herbarium of Surveys of Natural Resources Department, at Environmental Studies and Research Institute Sadat City University, Egypt and identified well using comparison with voucher specimens from the Cairo University herbarium . Pollen extraction and chemical preparations procedures of the flowers used are that described by [11].

Fig. 2: show location of eucalyptus globules trees growing at the industrial zone.

Fig. 3: show location of eucalyptus globules trees growing at the residential zone.

3.3 Microscopical examinations

The material for Light Microscopy (LM) was acetolysed according to [12] and [13]. For light microscopy, pollen grain were mixed with stained glycerin jelly and mounted on glass slides, while observations recorded with Trinocular Fluroscence Microscope (Axiostar HBO 50/AC Carl zeiss). For Scannining Electron Microscopy (SEM), pollen grains were suspended in a

drop of ethanol and transpired with a fine pipette to metallic stubs by using double sided cello tape and coated with gold palladium, with a thickness of 300 A, using a Jeol Jfc 1100 sputter coater. Examination using Tesla (BS 340) Scanning Electron Microscope (SEM) at Faculty of Agriculture Mansoura University. Selected SEM micrographs were then digitized and classified using image-analysis software.

The rectangular area for analysis was outlined in the mid- mesocolpium of each pollen grain, following method of [14]. The pollen terminology in general, follows [15], [16]and [17].

4. RESULTS

4.1 Climatic parameters

The maximum and minimum recorded temperatures in the area were 36.5 ºC and 5.6ºC, while the relative humidity (RH) ranges between 71.0% and 57.0%, averaging about summer and winter. The rainfall varies considerably from one season to another, while the average annual rainfall range is 30 mm/year and high evaporation rate (about 4.5mm/day in June). The highest value of wind speed (Km/hour) detected in March was 10.36 .while the lowest value detected in October was 6.475, (Tables.1, 2 and Fig.4).

4.2 Light and scanning Electron micrographs

Eucalyptus globulus Labill., that grow in the control studied area, produce pollen grains with mean size (23.7 um), trizonocolpate – syncolpate, with colpi fusing in each apocolpium to cut off an island of exine shaped like a triangular. Surface sculpture reticulate, exine quite thick distinguished to sexine and nexine (figure 5, a, c & d). While pollen grains of the same plant that grows in polluted industrial area, the triangular area has been reduced. Shrinkage of pollen size was observed (mean size 20.1 um), reticulation of the sculpture not clear. Deposition of some forgein particles on the surface sculpture of *E. globulus*. See (figure 5,b, e & f).

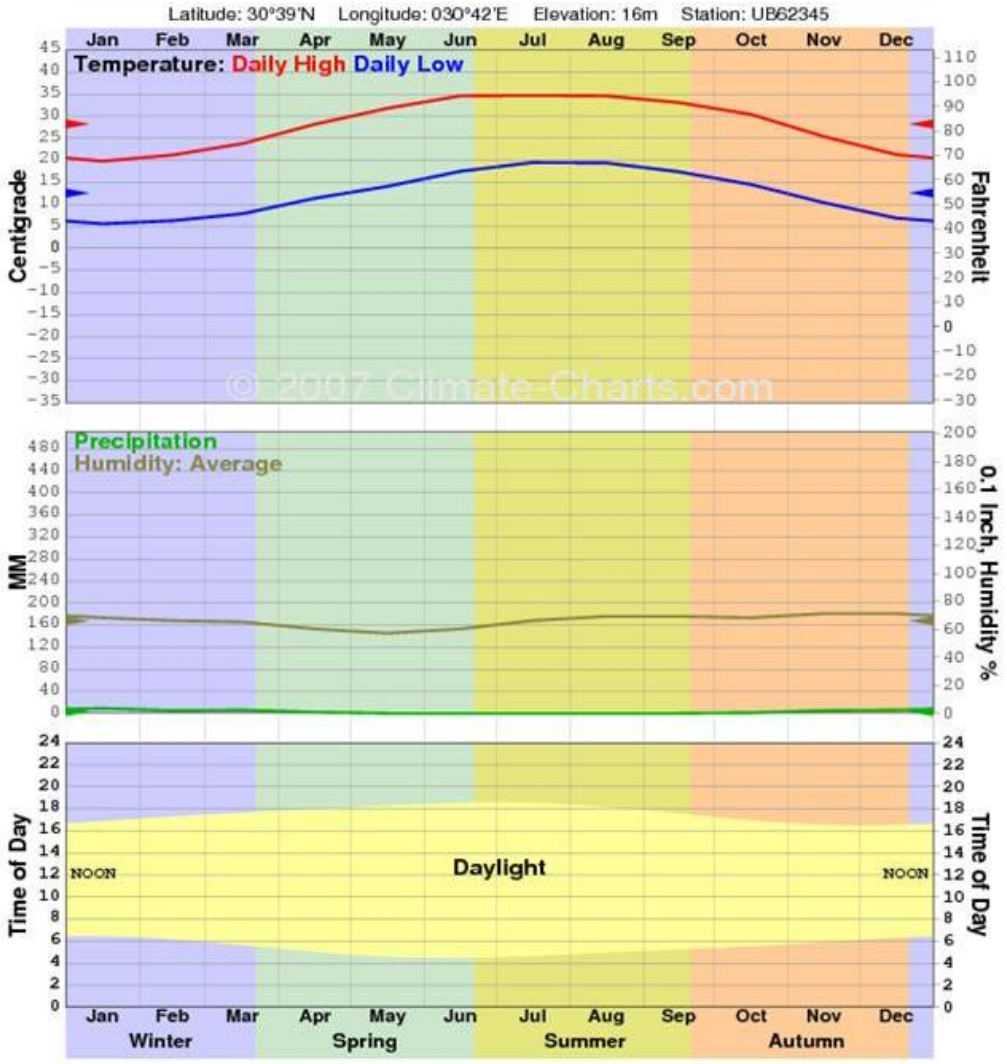

Fig. 4: Climate, Global Warming, and Daylight Charts and Data, Tahrir, Egypt: 2008.

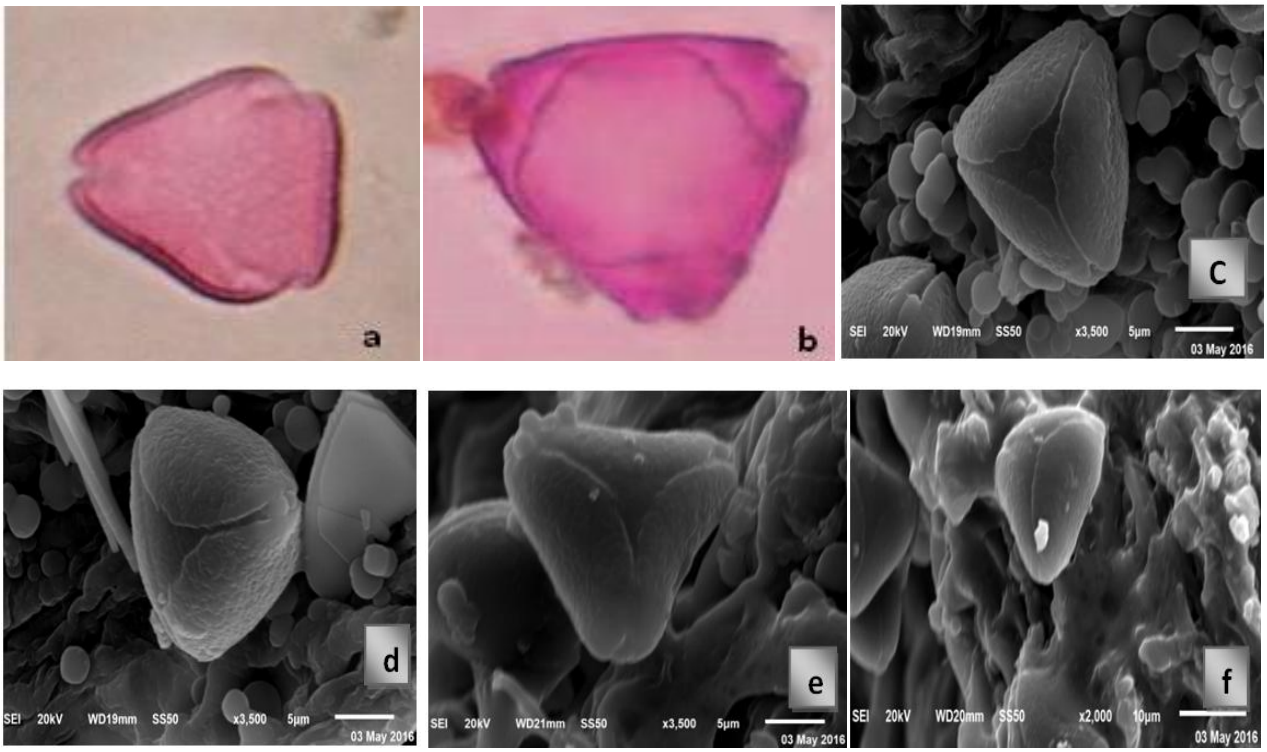

Fig. 5: Light (LM) and Scanning Electron Micrographs (SEM) showing pollen structure, photo. (a, LM micrograph) showing normal size, structure and sculpture of *Eucalyptus globullus* growing at unpolluted area. Photo. (b, LM micrograph) showing abnormal pollen morphology with unclear structure and sculpture at polluted area. Photo. (c and d, SEM micrograph) showing normal size, structure and sculpture of pollen un polluted area. Photo. e and f, showed some particulate matter was attached to its surface, shrinkage of pollen and abnormal shape of *Eucalyptus globullus* growing at polluted area.

5. DISCUSSION

5.1 Climatic Parameters of Sadat City

Sadat city area characterize by its extreme aridity, a long hot summer and short worm winter, this sever aridity climate greatly influences the hydrological properties of the drainage basins in the area [19]. According to data shown in Table.1 Sadat city area characterize by its extreme aridity, a long hot summer and short worm winter.

Gaseous pollutants and particulate matter arising from industry can affect the growth and survival of all living organisms. In many countries, forests nearby to industrial centers show obvious signs of damage from air pollutants. In China, sulphur dioxide and fluoride in the air have been linked to foliar damage in many trees, including Eucalyptus species adjacent to large cities [20], while pollution from cars can reduce the levels of photosynthetic pigments in Eucalyptus [21]. Other research has demonstrated that ozone (O3), which is a product of fuel combustion, can significantly reduce the weight and injure the leaves of certain species of Eucalyptus [22]. Eucalyptus trees exposed to chemicals in the air respond by the activation of enzymes such as peroxidases, ascorbate peroxidases and catalases, as well as by increasing the cellular levels of the antioxidant ascorbic acid, all of which help provide protection [23]. Air pollution, recently considered a global problem being faced by both developed nations as well as the non developing ones, it has been increased by developments these countries and become industrialized: growing cities, rapid economic development and industrialization, increased traffic and high levels energy consumption, all these factors affect each other and act as a synergistic effect to destroy the natural environment. [24]. Some plants being exposed to the pollutants (both gaseous and particulates) play a significant role as indicators and in evaluate the problem. They absorb, accumulate and keep the pollutants on their foliar surface, acting as the sinks for various pollutants and thus show the problem. The plants suffer from various deformities caused by the pollutants show diverse morphological, biochemical, anatomical and physiological responses [25]. On the other hand**,** [26] study the effects of air pollution caused by thermal power emissions on some foliar traits and found some changes in stomatal density, photosynthetic rate and chlorophyll content were reduced in the polluted plants in pre-flowering, flowering as well as post-flowering phases of plant growth. While, [24] found intercellular changes in concentrations of total flavonoids and phenolics in plants may serve as biomarkers of urban auto pollution.

The evolution of plants biomarkers use as a tool to monitor and evaluate the environmental state is closely linked to progress in our knowledge of molecular toxicity mechanisms of pollutants in different plant species in the ecosystem [27].

Table 1: Average values of climatic parameters of Sadat City (2004 – 2014) obtained from the Egyptian Meteorological of Tahrir Station.

Climatic factors / Months	Rainfall (mm)	Temperature (°C)	Relative humidity (%)	Evaporation (mm/day)	Wind velocity (km/hr)
January	30.0	5.6	56	2.7	10.2
February	22.0	17	53	2.9	11.5
March	10.2	20	43	3.5	12.8
April	1.2	30	48	4.6	12.2
May	0.0	34.6	57	5.5	10.3
June	0.0	35	65	5.7	10.5
July	0.0	36.5	67	4.9	10.2
August	0.0	35.5	71	4.7	8.5
September	0.0	30	58	4.1	8.4
October	2.0	27	58	4.3	8.6
November	2.0	24	57	3.1	8.7
December	9.1	20	57	2.9	10.3

Table 2: Average values of climatic parameters of Sadat City (2004 – 2014) obtained from the Tahrir Meteorological Station, Egypt.

Factor	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Temperature Mean Value	C	12.1	12.9	15.2	19.2	22.5	25.6	26.5	26.4	26.6	21.2	17.0	13.4	19.88
High Temperature Mean Daily Value	C	19.8	21.2	23.8	28.2	31.8	34.6	34.7	34.6	33.1	30.4	25.4	21.3	28.24
Low Temperature Mean Daily Value	C	5.6	6.3	7.9	11.4	14.1	17.5	19.5	19.4	17.4	14.5	10.4	6.9	12.58
Precipitation Mean Monthly Value	mm	9.0	5.0	6.0	2.0	0.0	0.0	0.0	0.0	0.0	1.0	5.0	6.0	2.83
Relative Humidity Mean Value	%	68.0	66.0	65.0	60.0	57.0	60.0	66.0	69.0	69.0	68.0	71.0	71.0	65.83
Wind speed	Km/hour	9.21	9.45	10.36	9.43	9.55	8.43	8.44	7.83	7.80	6.43	7.33	8.50	9.440

Table 3: Pollen morphological data (mean values, standard deviations, - mean-maximum for E, P, E/P [Dimensions, Shape class, Pollen shape, Pollen class (LM & SEM)] of *Eucalyptus globullus*.

Study area	Dimensasion (L.M)			Shape class	Pollen shape		Pollen class (LM & SEM)
	Polar axis P	Equatorial axis E	P/E		Polar	Equatorial	
Unpolluted area (Control)	21.7 (20.9 -22.8) µm	23.7 (24.2 -26.3) µm	1.3	isopolar	triangular	elliptical	Tri-colpate
Polluted area	17.4 (18.5- 20.2) µm	20.1 (21.1 -26.3) µm	0.90	isopolar	triangular	elliptical	Tri-colpate

5.2 Morphological studies of pollen and air pollution

Pollen morphology was not considered in the earlier taxonomic studies. While, Palynology can be helpful in solving problems related to plant systematics and can provide basis for additional features for identification of plant species [28]. The investigated *Eucalyptus globullus* pollen recorded morphological variation in size, shape, surface structure and surface pattern occurs in all studied acetolysed and unacetolysed pollen grain. In case of pollen of non polluted area pollen grains was observed with normal size, structure and sculpture this showed by LM and SEM micrograph Fig.5 (a, c and d)-Table.3, while in case of pollen of polluted of industrial area pollen grains was observed which showing slight fluctuation and showed shrinkage, breakage of exine (Fig.5b, e and f), whereas SEM studies of pollen grains of *Eucalyptus globullus* have observed with some particulates attached on surface of pollen (Fig.5e and f).

Scientists have concluded that the environmental factors, especially air pollution are responsible for increasing allergenicity of pollen [39] and [30]. Pollen grains are also found allergic to human beings. Air pollution can cause allergic symptoms but when attached with allergen pollen grains, the alleregenicity power are increased [31]. While Pollen of unpolluted area were nearly the same size in between 20-30 µm Table.3 Fig. 5(a, c and d) no far difference were observed in other characters, this agree with earlier study by [32]. Such studies will be valuable to know the harmful effects of air pollution on growth of plants.

6. CONCLUSION

Our present study revealed that, pollen morphology and surface structure were seen clearly with clear exine pattern, Trizonocolpate – syncolpate condition, normal size, structure and sculpture of control unpolluted area. While, pollen of polluted industerial area were affected by polluted air show damage in pollen structure, attached particulate matter on the pollen surface, thinning of exine, also shrinkage of the pollen was observed. Thus we can use the pollen morphological changes as a tool to the environmental air pollution.

Financial support and sponsorship: Nil.

Conflict of Interests: There are no conflicts of interest.

7. REFERENCES

1. Sengupta. S, Venkatachalam, P. Health Hazard As-sesment in an Industrial Town with the Help of Gram- GIS. *Environmental Monitoring and Assessment*, 1994; 32(2): 155-160.
2. WHO. 7 million premature deaths annually to air pollution; 12.5% of total global deaths. 25 March 2014 | Geneva World Bank Statistics Retrieved 2010-0829.
3. Rezanejad, F., Ahmad, M., Seyed M., Mostafa, M., Masoud A., And Maryam M. Effect of air pollution on soluble proteins, structure and cellular material release in pollen of Lagerstroemia indica L. (Lytraceae), *Acta Biologica Cracoviensia Series Botanica*, 2003; 45(1): 129–132.

4. Helender S. and Ahlholmj, A. Effects of air pollution and other environmental factors on birch pollen allergens. *Allergy,* 2003; 3: 1207–1214.
5. Carlo, D. and Paula, R. New insights into pollen evolution. Int J Plant Sci, 2004; 164: 835.
6. Shaltout, M. and Azzazi, M. F. Climate Change in the Nile Delta from Prehistoric to the Modern Era and Their Impact on Soil and Vegetation in Some Archaeological Sites. Journal of Earth Science and Engineering , 2014; 4:.632-642.
7. Erdtman, G. Pollen morphology and plant taxonomy; angiosperms. Almqvist & Wiksell, Stockholm. 1952.
8. BSBI List. *Botanical Society of Britain and Ireland*. 2007. *Archived from* the original *(xls) on 2015-02-25*. Retrieved 2014-10-17.
9. Hegazy, E. Study and follow up of microorganisms and inorganic pollutants of underground water at Sadat city, M. SC. Thesis, Microbial Biotechnology Department Genetic Engineering and Biotechnology Research Institute, Minufiya University. 2011.
10. http://eldoradocountyweather.com/
11. Moore, P.D. Webb, J.A. and Collinson, M.E. Pollen analysis. Blackwell, Oxford . 1991.
12. Erdtman, G. The acetolysis method: a revised description Svensk, Bot Tidskr. 1960; 54: 561–564.
13. Arora A. and Modi A. An acetolysis technique for pollen slide preparation. *Indian J. Aerobiol.* 2008; 21 (2): 90-91.
14. Vezey, E. L., Shah, V. P. & Skvarla, J. J. A numerical approach to pollen sculpture terminology. - PI. Syst. Evol. 1992; pp. 181.
15. Hesse, M. Halbritter, H., Weber, M., Buchner, R., Frosch-Radivo, A., Ulrich, S., Zetter, R. Pollen Terminology. An illustrated handbook, Publisher: Springer,Wien, NewYork. 2009.
16. Fægri, K. and Iversen, J. Textbook of Pollen Analysis. Munksgaard, Copenhagen; 3rd ed., 1975; p. 295.
17. Punt, W. Hoen, P. Blackmore, S. Nilsson, S. Le Thomas, A. Glossary of pollen and spore terminology. Rev Palaeobot Palynol, 2007; 143: 1–81.
18. Egyptian General Survey Authorities (EGSA). Wadi El Natrun, NH36-IID, Gabal Edeba, NH-12C 1:50000, Map produced by the irrigation Management system project. Surveying and Mapping component with Egyptian General Survey Authority under United Agency for irrigational Development project number. 1997; 263.
19. Azzazi, M. F. and Zahran, A. Study the Pollen Grains and the Concentration of Dust (TSP, PM10) in Desert Area and its Impact On Ecosystem- Case Study: Sadat City. Journal of Environmental Studies and Research Institute (ESRI), Egypt. 2008; 3:543-554.
20. Shu-Wen, Y. Guang, M. A and Lujia, J.U. Studies on the Causes of Forest Decline in Nanshan, Chongqing, Environmental Monitoring and Assessment. 1990; 14: 239-246.
21. Joshi, P. and Swami, A. Air Pollution Induced Changes in the Photosynthetic Pigments of Selected Plant Species. Journal of Environmental Biology. 2009; 30: 295-298.
22. Monk, R.J. and Murray, F. The Relative Tolerance of Some Eucalyptus Species to Ozone Exposure. Water, Air, & Soil Pollution. 1995; 85: pp. 1405-1411.
23. Seyyednejad, S.M. and Koochak, H. A Survey on Biochemical Effects of Industrial Air Pollution on Eucalyptus camaldulensis Dehnh. Journal of Food Agriculture & Environment. 2010; 8: 1272-1275.
24. Qayoom, M.A., Yazdani, T., Ahmad, S., Younas, M. Total flavonoids and phenolics in Catharanthus. and Ocimum sactum L. as Biomarkers of urban Autopollution .Caspian J. Environ. Sci., 2009; 7: 9-16.
25. Hasan Y. H. Air pollution in industrial area, North of Cairo with special reference to its effects on plants. Ph. D Thesis Cairo university. Faculty of science. 2000.
26. Nighat, F., Mahmood U., and Iqbal, M. Stomatal conductance, photosynthetic rate and pigment content in Ruellia tuberose leaves as affected by coal-smoke pollution. Biol. Plant. 2000; 43:263-267
27. Narbonne, J.F. Lagadic, L. Caquet, T. Amiard, J.C. Ramade, F. History - biological foundations of the use of biomarkers in ecotoxicology. In Utlisation biomarkers for monitoring the quality of the environment. Tec and Doc Lavoisier, Paris, 2000; p. 1-7.
28. Aftab R. and Perveen A. A palynological study of some cultivated trees from Karachi. Pak. J. Bot. 2006; 38 (1): 15-28.
29. Breiteneder,H and Scheiner,O. The environment and allergen expression. Internist (Beri). 1991; 32(10): 602-605.
30. Jileka, S., Breitenederh F., Ferreriaf S., Heberle, S., Rumpoldh, K. M and Breitenbachm. Biological functions, iso-forms and environmental control in the Bet v 1 gene family. In: Kraft D and Sehon A [eds.], Molecular biology and immunology of allergens, CRC press. Boca Raton, FL. 1993; pp. 39–46.
31. Chehregani, A. Majd, A. Moin, M. Gholami, M. Ali Shariatzadeh, M. Nassiri, H. Increasing allergy potency of *Zinnia* pollen grains in polluted areas. Ecotoxicol Environ Saf. 2004; 58(2):267-72
32. Nayar T. S. Pollen flora of Maharashtra State India. Today and Tommorows Publishers, New Delhi, India. 1990.

How to cite this article:

Azzazy M. Environmental Impacts of Industrial Pollution on Pollen Morphology of *Eucalyptus globulus* Labill. (Myrtaceae). J App Biol Biotech. 2016; 4 (05): 057-062. doi: 10.7324/JABB.2016.40509