Eco. Env. & Cons. 26 (April Suppl. Issue) : 2020; pp. (S27-S35)
Copyright@ EM International
ISSN 0971–765X

Parasitization of parasitic plants on fruit plants in Bangkalan regency and Malang City, Indonesia

Solikin

Research Center for Plant Conservation and Botanic Gardens, Indonesian Institute of Sciences, Jl. Raya Surabaya Malang km 65 Purwodadi Pasuruan East Java Indonesia

(Received 27 September, 2019; Accepted 10 January, 2020)

ABSTRACT

Parasitic plants is one of medicinal plant which grow as parasite and have potential to inhibit growing their hosts such as on fruit plants. Research aimed to know the parasitic plants and their hosts was conducted in Bangkalan Regency and Malang City East Java. The research used explorative and descriptive methods in homeyards or gardens on along edge of road sides tracked by inventory and recording the parasitic plants and their hosts obtained. The results showed that there were five species of parasitic plants which were parasitized on seventeen species of fruit plants as hosts. Mango (*Mangifera indica* L.) was the most dominant species of the fruit plant as a host of the parasitic plants in Malang City and Bangkalan Regency with IVI 73.57 and 172.79 respectively. *Dendrophtoe pentandra* (L.) Miq was the most dominant parasitic plant in Bangkalan Regency with IVI 162.51, whereas *Macrosolen cochinchinensis* (Lour.) Tiegh was the most dominant parasitic plant in Malang City with IVI 88.08.

Key words: *Parasitic plant, Dominant, Mangifera indica, Dendrophtoe pentandra, Macrosolen cochinchinensis*

Introduction

Parasitic plants are commonly found growing as parasites both on wild and cultivated plants species. Solikin (2014a) reported that there were 46 species of medicinal plants that had been parasitized by parasitic plants in Purwodadi Botanic Garden, whereas 17 of the plants species were parasitized by the parasites in agroforests in Pemping Island Batam (Solikin, 2017). Sometimes the parasite was found as a hyperparasite on other parasitic plants such as *Viscum articulatum* on *Dendrophtoe pentandra* (Solikin, 2016).

The parasites will inhibit plants growth and production by competition of water and nutrients absorbtion also photosynthates from their hosts. The parasitization of the parasites caused up to 75% growth inhibition, damage and death of distal branches on *Cassia fistula* in Purwodadi Botanic Garden (Solikin, 2016). The parasitic plants also caused reducing growth, yield and quality of wood and increase management operational costs of forests area (Department of Natural Resources Canada, 2012). Ohene (2011) reported that severe infection of the parasitic plants caused decreasing fruit production of citrus in Ghana.

Bediako *et al*., (2013) also reported that the parasitic plant caused stunted growth, mortality and reduced yield of citrus, i.e. 65%, 55%, and 95% respectively in Central Ghana. Thus, they must be controlled to optimize the fruit plants growth and yield.

Inventory of the parasitic plants and their hosts is needed to know their species and domination also controling the parasitic plants on the host plants. It is also important to control the parasitic plants as parasites or to cultivate them as medicinal plant sources.

Although the parasitic plants are known as parasite, they have been known and used by people as cancer drugs such as *Dendrophtoe pentandra* on mango for colon anticancer agents (Hardi, Wicaksono and Permana, 2013). It was also potential source for natural antioxidant and antidiabetes compounds (Artanti *et al*., 2012). *Viscum articulatum* was used as a hypertension drug (Bachhay *et al*., 2012), anticancer (Mutha *et al*., 2010), diuretics (Jadhav *et al*., 2010), antioxidants (Kuo *et al*., 2010), antiulcer (Naganjaneyulu *et al*., 2011), antiepileptic (Geetha *et al*., 2010), and immunomodulatory (Lu *et al*., 2011).

The efficacy of the parasite as a drug can be attributed to some chemical compounds contained in parasitic plants such as alkaloids, flavonoids, saponins, phenolic fractions of methanol-water and steroids (Daniel *et al*., 2012). Tripathi *et al*. (2013) reported that phenolic compounds in *Scurrula atropurpurea* and *Macrosolon cochichinensis* had broad spectrum for antibacterial activity.

This research is aimed to know diversity, composition, evenness and dominance of the parasitic plants on the fruit plants in Bangkalan Regency and Malang City.

Materials and Methods

Location and Time

The study was conducted in Malang City and Bangkalan Regency East Java Province. Obervation in Malang City was conducted in August 2014 and September 2018; Whereas in Bangkalan Regency carried out in August 2018. The observation of the parasitic plants and their hosts in Malang City was conducted in districs of Lowokwaru, Klojen, Sukun, Kedungkandang and Blimbing. Whereas study in Bangkalan Regency was conducted in districts of Burneh, Kamal, Arosbaya, Bangkalan and Socah (Figure 1).

Method

The study was conducted by exploring methods (Rugayah *et al*., 2004) in home gardens around residentials and gardens areas that were located around the road side passed. Data collection was conducted by inventory, identification and calculation of the species of the parasites and their hosts which were found and seen along the road that was passed during exploration. Observation and calculation of the parasitic on host plants were carried out using binocular and hand counters.

Fig. 1. Location map of the researches

Identification of the parasites and their hosts was conducted directly in the field by observing their morphological characters. Binocular was used to observe position of parasites on top branches. Taking photographs and making herbarium specimens were conducted for species identification.

The parasitic plants species determination refered to Backer and van den Brink (1965) and Barlow (1997).

Composition, dominance, diversity and evenness indice of the parasitic and their hosts were calculated by : a) Important Value Index (Krebs, 1994) ; b) Shannon Diversity Index (Maqurran, 2004); c) Domination Index (Maqurran, 2004); d) Evennes Index (Maqurran, 2004).

a. Important Value Index (IVI)

$$IVI = RD + RF \quad .. (1)$$

(Krebs, 1994)

$$\text{Relative Density (RD)} = \frac{\text{Individual number of species}}{\text{Total individual for all species}} \times 100$$

Relative Frequency (RF)

$$= \frac{\text{Frequency of a species}}{\text{Total frequency value of all species}} \times 100$$

b. Shannon diversity index

(Maqurran, 2004)

$$|H| = -\sum_{i=1}^{n} Pi \, Ln \, Pi$$

$$Pi = \frac{ni}{N}$$

ni = The number of individuals of the i species;
N = Total number of individuals for all species
H '= Shannon's diversity index

c. Domination Index (Simpson's domination index)

(3)

(Maqurran, 2004)

$$C = \sum_{=1}^{n} \left[\frac{ni}{N}\right]^2$$

C = Simpson's domination index
ni = i-species important value index
N = Total important value

d. Evenness index of plant species

.. (4)

(Maqurran, 2004)

$$e' = \frac{H'}{LnS}$$

e '= Species evenness index
H '= Shannon's diversity index
S = Number of species found
The evenness index range is as follows:
0 <e ≤ 0.5: Ecosystem is in stress and low evenness
0.5 <e ≤ 0.75: Ecosystem is in less stable condition and moderate evenness
0.75 e ≤ 1.0: Ecosystem is in a stable condition and high evennes.

Results and Discussion

Species of the parasitic plants

There were five species of the parasitic plants which parasitized the fruit plants both in Malang City and Bangkalan Regency, i.e. *Dendrophthoe pentandra* (L.) Miq., *Macrosolen cochinchinensis* (Lour.) Tiegh., *Scurrula atropurpurea* (Bl.) Dans., *Scurrula ferruginea* (Jack) Dans., and *Viscum articulatum* Burm. f. (Table 1). *S.atropurpurea* and *S. ferruginea* were not found on the fruit plants in Bangkalan Regency, while *V. articulatum* was not found in Malang City (Table 1).

The parasitic plants which were found both in Bangkalan Regency and Malang City were cathegorized as hemiparasite which required light for their photosynthesis and growth. Therefore the parasites position was generally found on branches or twigs exposed to direct sunlight. Solikin (2014a) reported that the position of the parasites on fruit trees was generally spread between branches III to VI from main stem, even for large host trees their position was on branch VII which was relatively opened and receive much directly sunlight. On these branches, the birds as the main spreader of the parasites is also more free to perch and disperse the seeds released simultaneously by their faeces or the seeds were vomited after eated.

Table 1 showed that *S.atropurpurea* and *S. ferruginea* were not found on the fruit plants in Bangkalan Regency, whereas *V. articulatum* was not found in Malang City. It is likely to be caused by their species as a source of seeds to disperse by the birds have not been found. The birds eat the seeds and then bring out them together with their faeces. The seeds will stick when they fall and attach to stem bark when the birds perch on the tree. It is an important factor for the parasitic plants dispersal because their dispersal in the community is mainly conducted by the birds. *V. Articulatum* (Figure 2E) which was not found in Malang, grew as a hyperparasite attached to the other parasitic plants especially on *D. pentandra* (Figure 2 A) in Bangkalan Regency. It was agreed with Solikin (2016) who reported that *V. articulatum* was commonly lived and grew as hyperparsite on other parasitic plants such as *D. pentandra* in Purwodadi Botanic Garden.

V. articulatum was not found parasitized the fruit

Table 1. The parasitic plants on the fruit plants in Malang City and Bangkalan Regency East Java

Species	Family	Malang City	Bangkalan Regency
Dendrophthoe pentandra (L.)Miq.	Loranthaceae	V	V
Macrosolen cochinchinensis (Lour.) Tiegh	Loranthaceae	V	V
Scurrula atropurpurea (Bl.) Dans	Loranthaceae	V	_
Scurrula ferruginea (Jack) Dans.	Loranthaceae	V	_
Viscum articulatum Burm. f.	Santalaceae	_	V

Note : V = Found - = Not Found

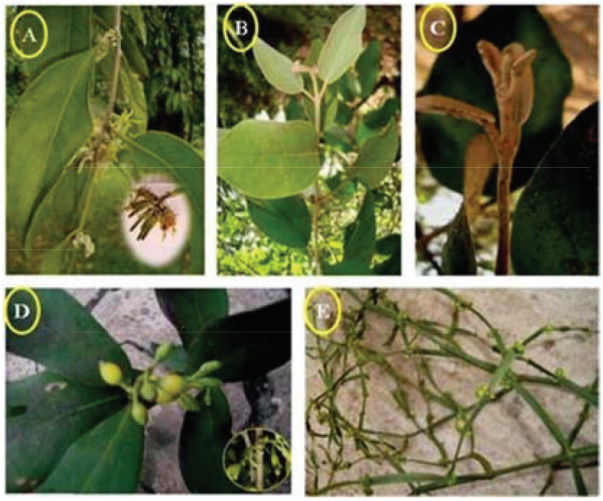

Fig. 2. Species of parasitic plants on the fruit plants in Malang City and Bangkalan Regency East Java: A), *Dendropthoe pentandra* B) *Scurrula atropurpurea.* C) *Scurrula ferruginea* D) *Macrosolen cochinchinensis,* E) *Viscum articulatum*

plants in Malang city. This may be caused by this species as the parasite source both on the fruit plants and other plant species was not found so there are not fruits that will be dispersed by birds to the host plants. Solikin (2016) reported that *V. articulatum* was a hyperparasite which was its life, population and distribution depended on other parasites, especially *D. pentandra*. Table 2 and Table 3 showed that *D. pentandra* was found both in Bangkalan Regency and Malang City but only in Bangkalan Regency *V. articulatum* was found. It may be found in other time or locations because the composition and population of the parasitic plants is dynamic. It is possible because of its dependency to other parasitic plants as hosts such as *D. Pentandra*. Solikin (2016) reported that the population of *V. articulatum* was depended on the population of *D. pentandra* as a host in Purwodadi Botanic Garden. This indicated that availability of hosts and parasites as sources parasites influenced the dispersal of the parasitic plants.

Parasitization of the parasites into host plants are preceded by sticking their seeds to surface of stem bark. It can be occured by vomited or eated seeds by birds fall along with their faeces on the branches when they perched. Aril of the seeds contain sticky viscin which cover the seeds and is not digested in stomach of the birds. The seed the parasites such as *D. pentandra* which was sticked to the surface of stem bark begin to germinate at about 11 days after sticking (DAS). The leaves will grow until 8 blades at 114 days after seed germinated with plant length about 10 cm (Solikin, 2014b). At the time of the parasite leaf and haustorium grow extensively, inhibition of the host plants growth increase until their branches dry and dye.

Host Plants

The fruit plants as host of the parasitic plants were different between Malang City and Bangkalan Regency. There were 14 species, 12 genera and 12 families of the fruit plants parasitized by parasitic plants in Malang City (Table 4). whereas in Bangkalan Regency, there were 8 species, 8 genera and 5 families of the fruit plants which were parasitized by the parasitic plants (Table 5). It was indicated that the species number of the fruit plants in

Table 2. Relative density (RD). relative frequency (RF) and important value index (IVI) of parasitic plants in Malang City East Java

Species	Family	RD	RF	IVI
Macrosolen cochinchinensis (Lour.) Tiegh	Loranthaceae	46.81	41.27	88.08
Dendrophthoe pentandra (L.)Miq.	Loranthaceae	14.89	16.67	31.56
Scurrula atropurpurea (Bl.) Dans.	Loranthaceae	36.17	38.89	75.06
Scurrula ferruginea (Jack) Dans.	Loranthaceae	2.128	3.175	5.30

Table 3. Relative density (RD), relative frequency (RF), and important value index (IVI) of parasitic plants in Bangkalan Regency East Java

Species	Family	RD	RF	IVI
Macrosolen cochinchinensis (Lour.) Tiegh	Loranthaceae	10.49	9.30	19.79
Dendrophthoe pentandra (L.) Miq.	Loranthaceae	81.12	81.40	162.51
Viscum articulatum Burm.f.	Santalaceae	8.39	9.30	17.70

Malang which has been parasitized by parasites more than those in Bangkalan Regency. Mango (*Mangifera Indica* L.) was the most dominant fruit plant in Malang City and Bangkalan Regency as a host of the parasite with IVI 73.57 and 172.79 respectively (Table 4, Table 5).

The fruit plants consisted of 10 major or popular fruits species such as as mango (*Mangifera indica*), avocado (*Persea americana*), sweet starfruit (*Averrhoa carambola*) and guava (*Psidium guajava*) and 4 minor or less popular fruit such as kepel (*Stelechocarpus burahol*), menuwa (*Annona reticulata*) and cerme (*Phyllanthus acidus*). The popular fruit plants were planted by many residents because of their high economic value and relatively easy to cultivate such as mango, avocado , sweet starfruit and guava. Whereas less popular fruits have low economic value and are rarely cultivated by the residents so they tend to be rare and endangered such as kepel (*Stelechocarpus burahol*), cerme (*Phyllantus acidus*), menuwo (*Annona reticulata*) and mulberry (*Morus alba*). There were 37 species of woody edible fruits in Malang City (Solikin 2015b) and 38 species of woody edible fruit plants in Madura including Bangkalan Regency (Solikin, 2012) which had potential to be parasitized by the parasitic plants. This meaned that the species of the fruit plants which have been parasitazied by the parasitic plants were 37.84% (Table 2) and 21.62% (Table 3) in Malang City and Bangkalan Regency respectively. Some species of fruit plants have not been found parasitized by the parasitic lants such as jackfruit (*Artocarpus heterophyllu*s), sawo kecik (*Manilkara kauki*), and jamblang (*Syzygium cumini*).

Table 4. Relative density (RD). relative frequency (RF) and important value index (IVI) of the fruit plants which were parasitized by the parasitic plants in Malang City

Species	Local name	Family	RD	RF	IVI	Note
Annona reticulata L.	menuwo	Annonaceae	2.27	2.33	4.60	Mn
Annona squamosa L.	srikaya	Annonaceae	2.27	2.33	4.60	Mn
Averhoa carambola L.	blimbing	Averrhoaceae	18.18	16.28	34.46	M
Citrus maxima (Burm.) Merr.	jeruk bali	Rutaceae	2.27	2.33	4.60	M
Citrus nobilis Lour.	Jeruk siem	Rutaceae	2.27	2.33	4.60	M
Lansium domesticum Corr.	langsep	Meliaceae	4.55	4.65	9.20	M
Mangifera indica L.	mangga;poh	Anacardiaceae	36.36	37.21	73.57	M
Morus alba L.	besaran	Moraceae	6.82	6.98	13.90	Mn
Nephellium lappaceum L.	rambutan	Sapindaceae	2.27	2.33	4.60	M
Persea americana Mill.	alpukat	Lauraceae	9.09	9.30	18.39	M
Phyllanthus acidus (L.) Schult.	cerme	Euphorbiaceae	6.82	6.98	13.8	Mn
Psidium guajava L.	jambu biji	Myrtaceae	2.27	2.33	4.60	M
Punica granatum L.	delima	Punicaceae	2.27	2.33	4.60	Mn
Stelechocarpus burahol (Bl.)Hook.f.&Th.	kepel	Annonaceae	2.27	2.33	4.60	Mn

Note : M = major; Mn = Minor

Table 5. Relative density (RD), relative frequency (RF), and important value index (IVI) of the fruit plants which were parasitized by parasitic plants in Bangkalan Regency East Java

Species	Local name	Family	RD	RF	IVI	Not e
Annona squamosa L.	sarkajeh	Annonaceae	2.82	1.56	4.38	Mn
Mangifera indica L.	pao	Anacardiaceae	84.51	88.28	172.79	M
Nephellium lappaceum L.	bunglon	Sapindaceae	4.93	3.13	8.05	M
Persea americana Mill.	apokat	Lauraceae	1.41	1.56	2.97	M
Psidium guajava L.	jembuh	Myrtaceae	0.70	0.78	1.49	M
Spondias pinnata (L.f.) Kurzt.	kedundung	Anacardiaceae	0.70	0.78	1.49	Mn
Syzigium samarangensis (Bl.) Merr.& Perry	klampok	Myrtaceae	0.70	0.78	1.49	M
Tamarindus indica L.	accem	Leguminosae	4.23	3.13	7.35	M

Note : M = major; Mn = Minor

Species Dominance and Important Value Indice

The domination of plants species can be shown by their IVI. Plant species which are able to adapt well to their habitat, they will grow dominance in their community. Species with high IVI have the great ability to maintain their growth and sustainability in the community. (Smith, 1977) stated that the dominance species was able to utilize the environment which was more efficient compared to other species in the same place. These species had IVI> 10% and they will grow dominance and stable in the ecosystem (Sutisna, 1981).

Table 2 showed that *D. Pentandra* was the most dominant parasitic plant on the fruit plants in Bangkalan Regency but it was not dominance in Malang City. In contrast, *M. cochinchinensis* was the most dominant parasitic plant in Malang City but it was not dominant species in Bangkalan regency.

D. pentandra has the highest IVI in Bangkalan Regency (Table 2) whereas *M. cochinchinensis* had the highest IVI in Malang City (Table 3). It was indicated that the domination of the parasitic plants in the two communities was different. Species and their dominance of the parasitic plants were influenced by their characteristics, location, climate, vegetation, time and ecosystem. Solikin (2014a) reported that there were five species of the parasitic plants obtained in Purwodadi Botanic Garden, i.e. *D. pentandra, M. tetragonous , S. atropurpurea, V. articulatum* and *V. ovalifolium*, whereas in agroforests in Kepala Jeri Island Batam was found three species of the parasitic plants, i.e. *Cassytha filiformis, V. stenocarpum* and *D. pauciflora* (Solikin 2016). *D. pentandra* was the most dominant parasitic plant in Purwodadi Botanic Garden, whereas *Cassytha filiformis* was the most dominant parasitic plant in Kepala Jeri Island (Solikin, 2016).

Local abundance of the parasitic plants and degree of constancy of host plants in time and space also affected preference of the parasitic plants in a community (Norton and Carpenter. 1998; Norton and Lange. 1999). *D. pentandra*, *M. cochinchinensis* and *S. atropurpurea* including the parasites which were commonly found and often dominated in several host plant species (Solikin, 2013; 2014a; 2015a). The presence of *D. pentandra* in Bangkalan regency was very dominance and the presence of this parasite can be predicted to be quite long as parasites in various plants species, because it did not only infect local fruit plants, but also other tree species, so this parasite can be categorized as a wide range parasite. The constancy of the host trees in the same space have potential to increase the dominance of this parasite continually. *D. pentandra* was reported as the parasite species which grow most dominance and the population continued to increase in the Purwodadi Botanic Garden from 2005 - 2013 and it has become a parasite in 46 species of medicinal plants (Solikin, 2014a). The presence this parasite is still the most dominant parasitic plant among other parasitic species in Purwodadi Botanic Garden until now.

The domination of *M. cochincinensis* in Malang City may be related to the characteristics of parasites and its environment where it may be more suitable for its growing than those in Bangkalan Regency. *M. cochinchinensis* more suitable in rather shaded canopy so it was often obtained in bottom canopy sheets. It also choose rather specific host plants with relative soft wood and bark such as *Mangifera indica*, *Ficus* spp. and *Streblus asper* in Puwodadi Botanic Garden. Soft bark and wood with high moisture content is preferred by parasite, because its haustorium can penetrate stem bark and tissue faster than hard wood to absorb water and minerals from the hosts stem.

Mangoes in Malang City were generally planted in yards or nerrow home gardens around residents houses where sunlight cannot be fully received all day on some parts of the plant canopy due to obstructed buildings. This microclimate appears to be suitable for the growth and dispersion of *M. cochinchineensis*. In Bangkalan Regency, mangoes were generally planted in the home yards or home gardens which were relatively large and sunlight can be received fully in most plant canopies and birds can fly and perch more freely among branches. This condition was suitable for the growth and *D. pentandra* dispersal among the plants.

Mango is the most dominant species of the fruit plants as a host of the parasitic plants both in Malang City and Bangkalan Regency. It was shown by the highest IVI among other fruit plants in Malang City and Bangkalan Regency , i.e. 73.57 and 172.79 respectively (Table 2 and 3). This can be caused by the highest population and density of this species among other fruit plants species. The population of productive mango in Malang city was 9871 trees in 2016 (BPS Malang Municipally, 2017) and in Bangkalan Regency was 669778 in 2016 (BPS Bangkalan Regency, 2017). The higher the plant

Table 6. Shannon diversity, evennes and dominance of the fruit plants which were parasitized by parasitic plants in Malang City and Bangkalan Regency East Java

Site	Shannon diversity index(H')	Evenness Index (e')	Dominance Index (C)
Malang City	2.09	0.79	0.19
Bangkalan Regency	0.69	0.33	0.75

Table 7. Shannon diversity, evennes and dominance of the parasitic plants in Malang City and Bangkalan Regency East Java

Site	Shannon diversity index (H')	Evenness Index (e')	Dominance Index (C)
Malang City	1.14	0.82	0.36
Bangkalan Regency	0.30	0.27	0.86

population of mango the higher the chance of the parasitic plants number to parasite mango. Mourão (2012) stated that increasing density and plant populations will increase the plants population parasitized from neighbor parasitized plants. This was also reported by Mourão *et al*. (2016) on *Mimosa calodendron* that the most abundance of this species as a host plants caused It had been infected by the parasitic plant *Struthanthus flexicaulis* more than other species in plant communities over Ironstone outcrops in the Iron Quadrangle region (Southeast Brazil).

Diversity and Evennes Indices

Species diversity in a community can be shown by its diversity index (H ') value; the higher the value, the higher diversity and stability of the community. H ' is cathegorized as low (H' <1), moderate (1≤ H 'e"2), and high (H'> 2) (Kent and Pady, 1992). Diversity Index of the fruit plants which was parasitized by the parasitic plants in Malang Regency and Bangkalan Regency was 2.09 and 0.69, respectively (Table 4). This can be categorized that the fruit plants which were parasitized by the parasitic plants in Malang was higher and more diverse than those in Bangkalan Regency. It may correlated with evenness and domination index of the fruit plants in the two location. Table 6 showed that evennes index value of the fruit plants in Malang City was higher than those in Bangkalan Regency. It indicated that the parasitized of the fruit plants in Malang City more diverse and spread on several species than those in Bangkalan Regency. This was also supported by their domination index in Malang was lower than those on Bangkalan Regency, which was not dominated by certain species. On the other hand, domination index of the fruit plants in Bangkalan Regency was high (0.75) which means that the parasitized fruit plants dominated by certain species. Table 2 showed that *Mangifera indica* was very dominant species as a host of the parasitic plants in even it was compared to the same species in Malang City. It indicated that this species has high risk to be parasitised by the parasitic plants.

Evenness index of the parasitic plants on the fruit plants in Bangkalan Regency was lower than those in Malang City (Table 7). It showed that the fruit plants tend to be parasitized by certain parasitic plants. Table 3 showed that *D. pentandra* was the most dominant parasitic plants in Bangkalan Regency with the highest IVI (162.51). It indicated that this species is very dominant in the community.

Conclusion

There were four and three species of the parasitic plants which were parasitized the fruit plants as hosts both in Malang City and Bangkalan Regency, respectively. Mango (*Mangifera indica* L.) was the most dominant species of the fruit plant as host of the parasitic plants in Malang City and Bangkalan Regency with IVI 73.57 and 172.79 respectively. *Dendrophtoe pentandra* (L.) Miq. was the most dominant parasitic plant in Bangkalan Regency with IVI 162.51 whereas *Macrosolen cochinchinensis* (Lour.) Tiegh was the most dominant parasitic plant in Malang City with IVI 88.08.

References

Artanti, N., Firmansyah, T. and Darmawan, A. 2012. Bioactivities Evaluation of Indonesian Mistletoes (*Dendrophthoe pentandra* (L.) Miq.) Leaves Extracts. *Journal of Applied Pharmaceutical Science*. 02 (01) : 24-27.

Bachhav, S.S., Bhutada, M.S., Patil, S.D., Baser, B. and Chaudhari, K.B. 2012. Effect of *V. articulatum* Burm. (Loranthaceae) in N$^{\omega}$- nitro-L-arginine methyl ester induced hypertension and renal dysfunction. *J. Ethnopharmacol.* 142(2): 467-73.

Backer, C.A . and van den Brink , B. 1965. *Flora of Java* Vol. II. NVP Noordhoff-Groningen. The Netherland. pp. 67-76.

Barlow, B.A. 1997. Loranthaceae. Flora Malesianan. In: Kalkman, C., Kirkup, D.W., Noteboom, H.P., Steven, P.F. and de Wilde, W.J.J.O. (Editors). *Seed Plants.* Rijksherbarium/*Hortus botanbicus*. Leiden. The Netherlands. I(13) : 209-401.

Bediako, A.A. E., Quaye, A. A. A., Tetteh, J.P., Buah, N., van der Puije G.C. and Acheampong, R.A. 2013. Prevalence of Mistletoe on Citrus Trees in The Abura-Asebu-Kwamankese District of The Central Region of Ghana. *Int. J. Scie & Tech. Res.* 2(7): 122-127.

BPS – Statistics of Bangkalan Regency. 2017. Bangkalan Regency in Figures. BPS – Statistics of Bangkalan Regency

BPS – Statistics of Malang Municipality. 2017. Malang Municipality in Figure. BPS – Statistics of Malang Municipality

Daniel, C.S. and Padin, M.S.L. 2012. Uji bioaktivitas beberapa fraksi dari ekstrak benalu sirsak (*Dendrophthoe pentandra* (L.) Miq.) yang berasal dari Kalimantan Timur. *Mulawarman Scientific.* 11(1) : 83-94.

Department of Natural Resources Canada, 2002. Technical Report RMRS-GTR- 98, September 2002.

Geetha, K.M., Gopal, P.V.V.S. and Murugan, V. 2010. Antiepileptic activity of aerial parts of *Viscum articulatum* (Viscaceae) in rats. *Journal of Pharmacy Research*. 3(12) : 2886.

Hardi, M., Wicaksono, B. and Permana, S. 2013. Potensi Fraksi Etanol Benalu Mangga (*Dendrophthoe pentandra*) sebagai Agen AntiKanker Kolon pada Mencit (*Mus musculus* Balb/c) setelah Induksi Dextran Sulvat (DSS) and Azoxymethane (AOM). J*urnal Biotropika*. 1(2): 75-79.

Jadhav, N., Patil, C.R. and Chaudhari, K.B. 2010. Diuretic and natriuretic activity of two mistletoe species in rats. *Pharmacognosy Research*. 2(1): 50-57. Kent, M. and Paddy, C.1992. *Vegetation Description and Analysis a Practical Approach*. Belhaven Press. London.

Kuo Y.J., Yan, Y.C. and Zhan, L.J., 2010. Flavanone and diphenylpropane glycosides and glycosidic acyl esters from *Viscum articulatum*. *J. Nat. Prod.* 73 (2): 109–114.

Krebs, C.J. 1994. *Ecology.* Fourth Edition. Harper Colleus Publishers, New York.

Lu, T.L., Chuang, J.Y., Yang, J.S., Chiu, S.T., Hsiao, N.W., Wu, M.C., Wu, S.H. and Hsu, C.H. 2011. Production of active nonglycosylated recombinant B-Chain of type-2 ribosome-inactivating protein from *Viscum articulatum* and its biological effects on peripheral blood mononuclear cells. *Evidence-Based Complementary and Alternative* Medicine. Article ID283747. http://dx.doi.org/10.1155/2011/283747.

Magurran, A. 2004. *Measuring Biological Diversity.* Blackwell Publishing, Oxford.

Mutha, R.E., Shimpi, R.D. and Jadhav, R.B. 2010. Study of preliminary anticancer potential of some hemiparasite plants. *IJPRD*. PUB. ARTI.2(1).

Mourão, F.A. 2012. Dinâmica do forrageamento da hemiparasita *Struthanthus flexicaulis* Mart. (Loranthaceae) e sua influência na estrutura da comunidade vegetal de campos rupestres ferruginosos – MG. PhD Thesis, Universidade Federal de Minas Gerais, Brazil.

Mourão, F.A., Pinheiro, R.B.P. and Figueira, C. 2016. Host preference of the hemiparasite *Struthanthus flexicaulis* (Loranthaceae) in ironstone outcrop plant communities, Southeast Brazil. *Acta Botanica Brasilica.* 30(1) : 41-46.

Naganjaneyulu, R., Kumar, C.K.A., Kumar, G.A., Dalith, M.D. and Basha, D.J. 2011. Antiulcer activity of *Viscum articulatum* Burm f. (Viscaceae) . I*nternational Journal of Innovative Pharmaceutical Research*. 2(2): 139-143.

Norton, D.A. and Carpenter, M.A. 1998. Mistletoes as Parasites, Host Specificity and Speciation. Trend. *Ecol. Evol*. 13 : 101-105.

Norton, D.A. and De Lange , P.J. 1999. Host specificity in parasitic mistletoe Loranthaceae) in New Zealand. *Funct. Ecol.* 13 : 552-559.

Ohene, G.C.B, 2011. Prevalence of mistletoe on citrus farms in the Akuapem-North district in the Eastern Region. B.Sc. Dissertation, Dept of Crop Sci, Univ. of Cape Coast, Cape Coast, Ghana.

Rugayah, Widjaja, E.A. and Pratiwi, 2004. Pedoman pengumpulan data keanekaragaman flora. Pusat penelitian biologi-LIPI, Bogor.

Smith, R.L. 1977. *Element of Ecology.* Harper & Row. Publisher. New York.

Solikin, 2012. Eksplorasi buah lokal Madura Jawa Timur. Prosiding Seminar Nasional Perhimpunan Hortikultura Indonesia. UPN Veteran 13-14 November 2012. PERHORTI. Dep. Agronomi dan Hortikultura. Fak. Pertanian . IPB. Bogor. pp. 258-265.

Solikin, 2013.Tumbuhan inang benalu pada suku Rutaceae di Kebun Raya Purwodadi. In: Sugiyarto, Mahajoeno,E. Chalimah, S. and H. Julendra, H. (eds). *Prosiding Seminar Nasional Pendidikan dan Saintec*. Prodi Biologi FKIP UMS. 12 Mei 2013. pp. 86-194

Solikin, 2014a. Parasitic plants on medicinal plants: Study in Purwodadi Botanic Garden. In: Rizal, M., N.M.Januwati,Y. Widyastuti, L. Brotokardono, R. Effendi, D. Rohadi and T. Herwati (eds). *Proceeding*

of International Seminar Proceedings Forest & Medicinal Plants for Better Human Welfare. Centre for Forest Productivity Research and Development, Bogor, 12-13 September 2013. pp. 35-46.

Solikin, 2014b. Upaya Perbanyakan Generatif Benalu *Dendrophtoe pentandra* (L.) Miq. P*rosiding Simposium Penelitian Bahan Obat Alami (SPBOA) & Muktamar XII PERHIPBA* 23-24 April 2014. PERHIPBA. PT Leutika Nouvalitera. Yogyakarta. pp. 529 - 535.

Solikin, 2015a. Benalu pada tanaman buah-buahan di Kota Malang. In: Setyawan A.D, Ridwan, M., D.W. Pamungkas, D.W., E.C.A. Ruspendi, E.C.A., Kharismamurti K., N. Muthmainnah, Lisa, N. and R.D.A. Putri, R.D.A. P*rosiding Seminar Nasional Biodiversitas*. Surakarta, 15 November 2014. pp.224-228

Solikin 2015b. Keragaman Jenis Tanaman Buah di Kota Malang. I In: Setyawan A.D, Ridwan, M., D.W. Pamungkas, D.W., E.C.A. Ruspendi, E.C.A., Kharismamurti K., N. Muthmainnah, Lisa, N. and R.D.A. Putri, R.D.A.. *Prosiding Seminar Nasional Biodiversitas*. Surakarta, 15 November 2014 4(3): 299-233

Solikin, 2016. Population Dynamic of *Viscum articulatum* Burm.f. on Its Host in Purwodadi Botanic Garden. *Journal of Biological Recsearches.* 21(2): 81-84.

Solikin, 2017. Diversity of parasitic plants and their hosts in Kepala Jeri and Pemping Agroforestry Batam Indonesia. *Journal of Biological Researches*. 23(1): 45-52.

Sutisna, U., 1981. Komposisi spesies hutan bekas tebangan di Batulicin, Kalimantan Selatan. Deskripsi and analisis (Laporan 328). Balai Penelitian Hutan, Bogor.

Tripathi, S., Ray, S., Das, P.K., Mondal, A.K. and Verma, N.K. 2013. Antimicrobial activities of some rare aerial hemiparasitic taxa of South West Bengal, India. *Journal of Phytopharmacology*. 4(2): 106-112.