Analysis of leaves trichomes of *Eclipta prostrata*, *Eleutheranthera ruderalis*, *Synedrella nodiflora*, and *Tridax procumbens* (Asteraceae, Heliantheae)

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Abstract. Asteraceae is a family of flowering plants distributed widely in the terrestrial regions. Asteraceae are grouped into several tribes. Species of the Heliantheae tribe including *Eclipta prostrata*, *Eleutheranthera ruderalis*, *Synedrella nodiflora*, and *Tridax procumbens* are the most commonly found at Universitas Indonesia Campus, Depok. The research was conducted to describe the morphology and the density of leaves trichomes as a species identification character and for classification purpose that has taxonomic value within several species of tribe Heliantheae. The digital images of leaves were captured using a Dino-Lite digital microscope device and Dino capture 2.0 application to measure the area of leaves and the number of trichomes. The number of trichomes was calculated using ImageJ software. The light microscope was used to observe the trichome morphology. The results showed that trichomes density in young leaves was higher than in the old leaves. *Eclipta prostrata*, *Eleutheranthera ruderalis*, and *Synedrella nodiflora* showed micromorphology of trichome with ornamentation on the surface of the trichome, while *Tridax procumbens* not. The numbers of leaves trichomes per unit area were also different between species of Heliantheae tribe. *Eclipta prostrata* has the lowest number of trichomes density with a range of trichomes from 1.15/mm² to 6.375/mm² on the surface of young leaves and old leaves. *Synedrella nodiflora* has the highest trichomes density with a range of trichomes from 2.68/mm² to 15.71/mm². The four members of the Heliantheae tribe have a higher density of leaves trichomes on the lower surface (abaxial) than the upper surface (adaxial) of the leaves.

1. Introduction

Asteraceae (Compositae) is one of a very large family of angiosperms. The family consists of more than 1,620 genera and 23,600 species [1]. Funk [2] described the family of Asteraceae comprises 43 tribes, 1600—1700 genera, and 24000—30000 species. Asteraceae members are mostly herbaceous plant, and a few are trees and shrubs. The members of this family have a diversity of habit and habitat distributed worldwide [3].

Trichomes are formed and developed outwards on the surface of any part of the plant organs both vegetative and reproductive structures such as leaves, stems, fruits, and sepals [4]. The trichomes
mostly present in the form of unicellular and multicellular that originate from epidermal outgrowth. Another characteristic of distinction between trichomes type is non-glandular and glandular hairs. The different taxa of plants may significantly vary and have diversity in location, morphology, size, surface microstructure, the ability of secrete, type of secretion, and function. These features provide for classification purposes [5].

Plants in the family of Asteraceae have economic value as ornamentals, medicinal, weeds, and green vegetables [6]. Both of multicellular and unicellular trichomes secrete some chemical compounds for specialized function such as essential oils [7]. These secretory trichomes are called glandular trichomes. The chemical compounds may present for chemical protection (against pathogens and herbivores) and support pollination. Another trichome type, non-glandular hairs serve as protection (from herbivores, radiation of the sun), reduce heat load of the plants, increase freezing tolerance, help seed dispersal, and hold water balance of plants [8].

Previous research has described the morphology of some species in Asteraceae [1, 6, 7]. The morphology and density of trichomes have also studied in some plants, may aid the variability of trichome characters for plant taxonomy between taxa [8, 9, 10]. This study aimed to determine the morphology and trichomes density of some species which can be useful for characterization among taxa in Heliantheae tribe.

2. Materials and Method
Fresh leaves of the four members (Eclipta prostrata, Eleutheranthera ruderalis, Synedrella nodiflora, and Tridax procumbens) were collected in some location near Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Indonesia Campus, Depok. Five samples for each young and old leaves were collected from each species. Each leaf sample was observed using a Dino-Lite digital microscope device and Dino capture 2.0 application. Adaxial and abaxial of leaf were measured at magnification 67x with a sample size of 24 mm2. The obtained leaf images were observed using ImageJ software to calculate the number of trichomes. The number of trichomes per mm2 calculates trichome density.

The observation of the trichome morphology was done using a blended fresh leaf that was previously prepared. Trichome sample was prepared by mixing one leaf with 300 ml water using an electric blender for 15 to 20 seconds to get a rough leaf cut. Prolonged of blending time will make the texture of blended leaf damage, and it was not good sample trichome observation. The samples were then observed under the light microscope with 10-40x magnifications.

3. Results and Discussion
The types of trichomes observed were glandular and non-glandular as shown in Table 1. There are unique differences in the types of non-glandular trichomes between the four species. Ornamentation is present on the outer surface of the trichomes in E. prostrata, S. nodiflora, and E. ruderalis, but absent in T. procumbens as shown in Figure 4. The Non-glandular type of trichome in the four species has the most distribution compared to glandular trichome. Eclipta prostrata and S. nodiflora have similar non-glandular trichomes with a pointed tip and ornamentation along the surface of the trichome, while E. ruderalis and T. procumbens have similar trichomes type with multicellular stalk and long pointed tip.

**Figure 1.** Four micromorphology of trichomes variation, Eclipta prostrata (A), Synedrella nodiflora (B), Eleutheranthera ruderalis (C), and Tridax procumbens (D).
Table 1. Morphology of trichomes in various species of Heliantheae.

| Species              | Type of trichomes                                      | Micromorphology                                      |
|----------------------|--------------------------------------------------------|------------------------------------------------------|
| *Eclipta prostrata*  | A. Uniseriate, non-glandular, pointed tip              | Ornamentation on the outer surface of non-glandular trichome |
|                      | B. Uniseriate, glandular, multicellular stalk           |                                                      |
| *Eleutheranthera ruderalis* | A. Uniseriate, non-glandular, multicellular, pointed and long tip | Ornamentation on the outer surface of non-glandular trichome |
|                      | B. Uniseriate, glandular, multicellular stalk           |                                                      |
| *Synedrella nodiflora* | A. Uniseriate, non-glandular, long stalk, pointed and sharp tip | Ornamentation on the outer surface of non-glandular trichome |
|                      | B. Uniseriate, glandular, multicellular stalk           |                                                      |
| *Tridax procumbens*  | A. Uniseriate, non-glandular, multicellular, pointed and long tip | No ornamentation observed                            |
|                      | B. Uniseriate, glandular, bicellular stalk             |                                                      |

Trichome types of several species from the Asteraceae family have been studied, that trichomes characters are also useful for distinguishing between different taxa [1, 6, 7, 11, 12]. In the present study, trichomes were observed in young and old leaves. There were no difference of trichomes morphology of young leaves and old leaves, but differences were observed in the forms of trichomes in *S. nodiflora*. Trichome with long sharp tips as shown in Figure 2.iii.A was found in young leaves, while in old leave, the tip is short as shown in Figure 3.iii.A.

All trichomes observed were uniseriate. Non-glandular trichomes with pointed tip characters are found in *E. prostrata* and *S. nodiflora* as shown in Figure 2.i.A, 3.i.a, 2.iii.A, and 3.iii.A. Non-glandular multicellular types with long, sharp tips are found in *E. ruderalis* and *T. procumbens* as shown in Figure 2.ii.A, 3.ii.A, 2.iv.A, and 3.iv.A. *E. prostrata*, *S. nodiflora*, and *E. ruderalis* have a type of glandular trichome with a multicellular stalk as shown in Figure 3.iB, 2.ii.B, 3.ii.B, 2.iii.A, and 3.iii.A. The form of glandular trichomes with bicalar stalk is observed only in *T. procumbens* as shown in Figure 2.iv.B and 3.iv.B.

![Figure 2](image_url) Trichomes types in the old leaves of *Eclipta prostrata* (i), *Eleutheranthera ruderalis* (ii), *Synedrella nodiflora* (iii), and *Tridax procumbens* (iv).
The leaves of four species are amphitrichomic, which the distribution of trichomes found in the abaxial and adaxial of leaves. The density of trichomes each species varies in number. The high density of trichomes in four species was found on abaxial leaves than adaxial leaves. Young leaves have more trichomes than old leaves. The effects of age in the density of trichomes on other species have also been studied and show that with increasing leaf age, the leaf trichome density decreases due to expansion of leaf size [4].

*S. nodiflora* has the highest trichomes density in the abaxial of young leaves and old leaves, while the highest trichomes density is *T. procumbens* in the adaxial of young leaves and old leaves. The lowest trichomes density is found in young leaves and old leaves of *E. prostrata* as presented in Table 2 and Figure 4.

![Figure 3. Trichomes types in the young leaves of *Eclipta prostrata* (i), *Eleutheranthera ruderalis* (ii), *Synedrella nodiflora* (iii), and *Tridax procumbens* (iv).](image)

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**Table 2. Density of trichomes in old leaves and young leaves (number of observed trichomes per mm²)**

| Species                  | Adaxial Young Leaves | Abaxial Young Leaves | Adaxial Old Leaves | Abaxial Old Leaves |
|--------------------------|----------------------|----------------------|--------------------|--------------------|
| *Synedrella nodiflora*   | 3.13                 | 15.72                | 2.68               | 11.98              |
| *Eclipta prostrata*      | 1.15                 | 6.38                 | 2.17               | 4.86               |
| *Tridax procumbens*      | 4.98                 | 7.09                 | 4.35               | 5.01               |
| *Eleutheranthera ruderalis* | 4.78              | 10.18                | 2.74               | 7.08               |
4. Conclusions
The trichome of the four species of Heliantheae tribe investigated in this study can be used as distinguishing characters. The presence of ornamentation on the outer surface of the trichomes, and the trichome density of some species, was significantly different. The present study shows that the highest density of trichomes found in the abaxial of leaves.

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