Ectoparasites of mangrove crabs (Scylla serrata) and white shrimps (Litopenaeus vannamei) from Gresik, Indonesia

by S. D Puspitasari

Submission date: 24-May-2023 03:31PM (UTC+0800)
Submission ID: 2100678694
File name: JVP_Puspitasari.pdf (636.65K)
Word count: 2597
Character count: 14171

Journal of Veterinary Parasitology, 34(1)2020:32-36

Ectoparasites of mangrove crabs (*Scylla serrata*) and white shrimps (*Litopenaeus vannamei*) from Gresik, Indonesia

S.D. Puspitasari, P.D. Wulan Sari[1]* and Kismiyati

Faculty of Fisheries and Marine, Universitas Airlangga, Surabaya-Indonesia, 60115

Received: 05.02.2019 **Revision: 26.03.2020** **Accepted: 05.06.2020**

Abstract

The ectoparasites that infest two hosts, mangrove crabs (*Scylla serrata)* and white shrimps (*Litopenaeus vannamei)* of the subphylum crustacea were studied. The study revealed that *Octolasmis* sp., *Zoothamnium* sp. and *Epistylis* sp. were found to infest mangrove crabs, while *Zoothamnium* sp. and *Epistylis* sp. were found parasitizing the white shrimp (*Litopenaeus vannamei*). The most common organ attacked by the ectoparasites was the gills. Stagnant water with limited or no flow of water in the ponds was an important factor that supported the infestation of parasites.

Keywords: **Arthropod, Ectoparasite, Mangrove crabs, Protozoa, White shrimp.**

Introduction

Mangrove or mud crabs (*Scylla serrata*) are one of the crustaceous decapod groups which are important fishery commodities in Indonesia. Several cultivation methods have been developed to increase the production of both commodities. The development of the mangrove crab trade business has continued to increase until now because of the wide-open export market opportunities with considerable potential for mangrove areas and increasing technology for both cultivation and capture. (Center for Fish Quarantine and Fish Safety, 2016).

Another important fishery commodity produced by Indonesia is white shrimp (*Litopenaeus vannamei)*. White shrimps were officially introduced to the cultivating community in 2001 after a decline in tiger shrimp (*Penaeus monodon*) production due to various problems encountered in the production process, both technical and non-technical problems (Subyakto *et al*., 2009). In line with a large number of enthusiasts for shrimp farming, there are also a number of problems that interfere, thus hampering the development of aquaculture, namely the presence of parasites that can inhibit shrimp growth.

[1]Department of Fish Health Management and Aquaculture, Faculty of Fisheries and Marine,
*Corresponding author. Email: putri.dw@fpk.unair.ac.id

DOI: 10.5958/0974-0813.2020.00006.6

Several studies on ectoparasite infestations in both mangrove crabs and white shrimps have been reported. Ectoparasites *Chilodonella* sp., *Ichthyobodo* sp., *Epistylis* sp., *Carchesium* sp., *Vorticella* sp., *Octolasmis* sp., and *Lepeophtherius* sp. were found to be able to infest mud crab and white shrimp (Sarjito *et al*., 2016; Maldini *et al*., 2017; Hamid *et al*., 2019; Hafidloh and Sari, 2019).

This research was conducted to determine the types of ectoparasites that infest mud crabs and white shrimps. The coastal waters in Gresik Regency were chosen because one-third of the Gresik area is a coastline with a length of 140 km stretching from the Districts of Kebomas, Gresik, Bungah, Panceng, and Ujungpangkah (Statistics of Gresik Regency, 2011).

Materials and Methods

Eighty mud crabs (*S. serrata)* with weights ranging between 100-200 g were collected from fattening culture in Ujung Pangkah coast water Gresik, Central Java, Indonesia. A total of 150 white shrimps (*L. vannamei*) with weight ranging between 9-20 g each were collected from brackish water pond, in Ujung Pangkah coast water Gresik, Central Java, Indonesia. Observations on gill filaments and leg scrapings of the mud crabs and white shrimps were made using a binocular microscope. Illustrations were made with the camera lucida attached to the microscope.

Results and Discussion

In this study, arthropods and protozoan ectoparasites infesting the gills of mud crab were *Octolasmis* sp., *Epistylis* sp. and *Zoothamnium* sp. While in white shrimp the protozoan ectoparasite infesting the gills were *Epistylis* sp. and *Zoothamnium* sp. (Table 1).

Table 1. Ectoparasites of mud crab (*S. serrata)* and white shrimp (*L. vannamei*)

Genus	Predilection	*Scylla serrata* (80)		*Litopenaeus vannamei* (150)
		Male	Female	
Octolasmis	Gills	55	21	-
Epistylis	Gills	20	48	67
Zoothamnium	Gills	23	11	-
	Gill Filament	-	-	37

Ectoparasites:

The observations on the morphology of ectoparasites of mud crabs (*S. serrata*) and white shrimps (*L. vannamei*) showed slight differences when compared to those that have been recorded by Ma and Overstreet (2006), Jie *et al.* (2006), Chan *et al.* (2009), Ihwan *et al.* (2014), Xinlu *et al.* (2014) and Shinn *et al.* (2015).

Octolasmis *sp.:*

Octolasmis (Fig. 1) were found with capitulum, scutum, tergum, and carina. The posture of the capitulum and the peduncle were up-straight with a capitulum shaped like a pointed oval on the dorsal portion. There were three plates in the capitulum, namely the carina, a pair of gums and a pair of scutum in the middle of the capitulum. Ectoparasites of the genus *Octolasmis* in this study were found only on the gills because a lot of nutrients are contained in the gills, also their life cycles require more nutrition than that required by the protozoan parasites (Jeffries *et al*., 2005). Irvansyah *et al*. (2012) stated that gills are one of the organs that are well supplied by the blood. There are blood vessels that are protected by a thin layer of tissue which makes it easy to be attacked by ectoparasites. Ectoparasites are very rarely found in swim foot or carapace because the protective tissues had very hard texture and are actively used for swimming and walking so that it is difficult for ectoparasites to hold on.

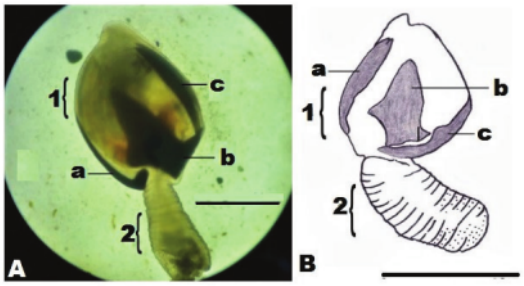

Fig. 1. Photomicrograph of *Octolasmis* sp. (A) and (B) camera lucida drawing showing anterior side (1) peduncle (2) with (a) carina (b) scutum and (c) tergum (Bar in both-20µm)

Epistylis *sp.:*

The body of *Epistylis* (Fig. 2) was found to be in the shape of a bell on a branching stalk, resembling a thin and long funnel. *Epistylis* had a bell-shaped zooid form which was slender elongated with the size average 40-50 µm and there was a peristome in anterior zooid. They lived in a colony form and were sometimes found with zooids loose from the stalk. Live, sessile *Epistylis* observed in this research had a branched stalk, 10 µm in diameter. There was an anterior cilium in the zooid. *Epistylis callinectes* previously has been identified by Ma and Overstreet (2006), where it is found that the genus *Epistylis* with features of a rounded body with a very small anterior tip whose diameter is much different from its zooid, transparent body as the cause of food vacuole and has a strong stalk to grip the host.

J.Vet.Parasitol.200-0064-480/$2.50 © IAAVP, India

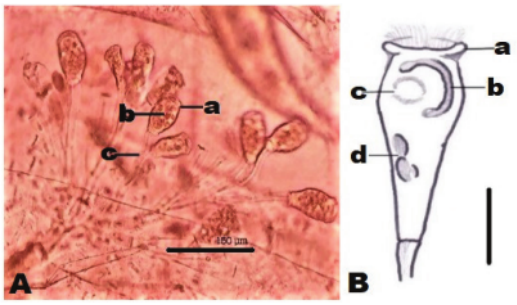

Fig.2. Photomicrograph of *Epistylis* sp. (A) and (B) camera lucida drawing showing (a) peristome (b) contractile vacuole (c) macronucleus and (d) food vacuole (Bar in A-150 µm and B-20 µm).

Zoothamnium *sp.:*

Zoothamnium (Fig. 3) was found in mud crabs and white shrimps with a bell-shaped zooid 42-50 µm in diameter. The contractile vacuole was single and there was a macronucleus at the bottom of the peristome. They were found in mud crab and white shrimp, attached to gill filaments. Andrew *et al*., (2004) found that *Zoothamnium duplicatum* in the gills of *Litopenaeus setiferus* caused anoxia where oxygen exchange in the gills was very limited. The *Zoothamnium* found in the oval zooid morphology where the lip diameter (peristome) is smaller than the zooid body and very thin. In the study of Jie *et al*., (2004), *Z. duplicatum* had an oval body and tended to be round with a small peristome on the anterior part. *Zoothamnium* had a transparent body that has an average zooid size of 30-45 µm and a stalk 10 µm in diameter. Firdaus and Ambarwati (2019), as well as Mahasri *et al*. (2016) identified the existence of *Zoothamnium* infestation in ponds due to the accumulation of artificial feed which was not consumed at the bottom of the pond, thereby affecting the content of organic matter.

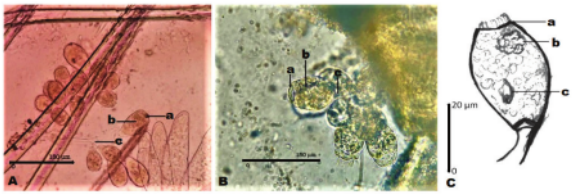

Fig 3. Photomicrograph of *Zoothamnium* sp. in infested mud crab (A) and from infested white shrimp (B) and camera lucida drawing (C) showing (a) peristome (b) macronukleus and (c) contractile vacuole (Bar in A and B 150 µm and in C 20 µm).

The study showed that the most common organ attacked by ectoparasites was the gills. This could be because gills are the respiratory organs that have direct contact with the environment which filters out materials, feed particles and bind oxygen. According to Yuliarti (2011) the location of gills, their structure and contact mechanisms with the environment make gills more vulnerable to the changes in the environmental conditions and thereby gills become more vulnerable to infection by ectoparasites.

Ectoparasites of genus *Epistylis* were found in environments with low water quality, a lot of organic matter and less intensive handling (Pritchett and Sanders, 2007). This follows the condition of the research pond where a traditional culture method that doesn't use waterwheels providing several kinds of organic material as a plankton grower, is still used. This system causes protozoan ectoparasites such as *Epistylis, Zoothamnium* to reproduce well as the required nutrients for the ectoparasites were well fulfilled. Also, poor water quality which is influenced by uncontrolled environmental factors can cause a lack of nutritional needs, so that ectoparasites can attack shrimp easily. Jithendran *et al*. (2010) stated that fouling protozoans such as peritrichous ciliates may be a problem especially if associated with poor water quality due to elevated nutrient and organic matter.

We analyzed that the growth of protozoan ectoparasites in this research was supported by the pond condition which had stagnant water with limited or no flow. This is suspected because the fish culture pond still used in the traditional culture system where waterwheels are not used in these ponds. In a study by Utami (2013), it was stated that ectoparasites in no-flow water could potentially increase. Ectoparasite attacks are a result of the inconsistency between the environmental conditions and the host which creates weak self-defense against ectoparasites. If the water quality is low, it can affect the health condition of fish, so the fish that were already presented in the pond are infected by the parasites. Severe infestation of the parasites in fish will cause organ damage in the gills and cause anemia and even

J.Vet.Parasitol.200-0064-480/$2.50 © IAAVP, India

mortality (Saptiani *et al.,* 2017). This is due to the ability of certain ectoparasites in adapting to the environment they grow. According to Fenchel and Finlay (2006), the environmental conditions that support infestation with ectoparasites are temperature range of 28 to 35°C, 17 ppm in salinity, pH range of 7.63 - 8.80 and 3-4 ppm of dissolved oxygen.

Conclusion

The ectoparasites *Octolasmis*, *Epistylis* and *Zoothamnium* were found infesting mud crab and white shrimp with *Zoothamnium* were found to infest both hosts. Sub-optimal water conditions in the pond, including stagnation was found to increase parasitism.

Acknowledgements

The authors would like to thank the fish farmers in Ujung Pangkah coast water Gresik, Central Java, Indonesia. They are also grateful to the Faculty of Fisheries and Marine Universitas Airlangga for the research support.

References

Andrew, P.S., P.M. Alexander., C.J. Christoper., Metophis, and A.F. Mark., 2015. *Zoothamnium duplicatum* infestation of cultured horseshoe crab (*Limulus polyphemus*). J. Invert. Pathol., 125: 81-86.

Center for Fish Quarantine and Fish Safety, 2016. Pedoman pemeriksaan/identifikasi Jenis ikan Dilarang Terbatas (Kepiting Bakau/*Scylla* spp.). Fish Quarantine Agency, Fisheries Product Quality and Safety Control. Marine and Fisheries Ministry. Jakarta. 47 p (in Indonesia).

Chan, B.K.K., Prabowo, R. E. and S. Lee., 2009. Crustacean fauna of Taiwan, Barnacles, Volume I, Cirripedia, Thoracia Excluding the Pyrgomatide and Acastinae. National Taiwan Ocean University. 164 p.

Fenchel, T and Finlay, B.J., 2006. The diversity of microbes: resurgence of the phenotype. Philos. Trans. R. Soc. London B. Biol. Sci., 361(1475):1965–1973.

Firdaus, I.A., and Ambarwati, R. 2019. The infection rate of Ciliophora ectoparasites on vannamei shrimp (*Penaeus vannamei*) in Sidoarjo's polyculture ponds. Lentera Bio, 8(2): 127-135.

Hafidloh, U. and Sari, P.D.W., 2019. Protozoan parasites of cannamei shrimp (*Litopenaeus vannamei*) in farmed fish from Pasuruan, Indonesia. IOP Conf. Series: Earth Environ. Sci., 236: 012091.

Hamid, Z., Sari. P.D.W. and Mahasri, G., 2019. Dual infection of fungus and *Octolasmis* species in mangrove crabs (*Scylla serrata*) in Gresik, East Java. J. Vet. Parasitol/, 33(1): 35-40.

Ihwan, M.Z., Ikhwanuddin, M. and Marina, H., 2014. Morphological distribution of peduncle barnacle *Octolasmis sp.* found on gill of wild mud crab (Genus: *Scylla*) from Trengganu Coastal Waters, Malaysia. JAFS, 9: 366-371.

Irvansyah, M. Y., Abdulgani, N. and Mahasri, G., 2012. Identifikasi dan Intensitas Ektoparasit pada Kepiting Bakau (*Scylla serrata*) Stadia Kepiting Muda di Pertambakan Kepiting, Kecamatan Sedati, Kabupaten Sidoarjo. J. Sains dan Seni ITS., 1(1):1-5.

Jeffries, W. B., Voris and Yang, C., 2005. Growth of *Octolasmis angulata* (Aurivillius, 1892) on the gills of *Scylla Serrata* (Forskal, 1755). Biol. J., 1 (169): 291-296.

Jie, D., Song, W. and Warren, A., 2006. Redescriptions of three marine peritrichous ciliates, *Zoothamnium alternans* Claparède et Lachmann, 1859, Z. sinense Song, 1991 and *Z. commune* Kahl, 1933 (Ciliophora: Peritrichia), from north China. Acta Protozool., 45 (1) : 27–39.

Jithendran, K.P., Poornima, M., Balasubramanian, C.P. and Kulasekarapandian, S., 2010. Disease of mud crabs (*Scylla* spp.) : an overview. Indian J. Fish., 57(3) : 55-63.

Ma, H. and Overstreet, R.M., 2006. Two new species of *Epistylis* (Ciliophora: Petrichida) on the blue Crab (Callinectessapidus) in the Gulf of Mexico.

Department of Coastal Science, The University of Southern Mississippi. Ocean Springs, Eukaryot. Microbiol., 53(2): 85-95.

Mahasri, G., Heryamin, A. and Kismiyati, 2016. Prevalence of ectoparasites on white shrimp (*Litopenaeus vannamei)* with different stocking density in larva rearing ponds in Gresik. JAFH, 5(2) : 7-13.

Maldini, A., Winaruddin, Bakri, M., Hambal, M., Farida, and Daud. R., 2017. Identification of ectoparasites in the mud crab (*Scylla serrata*) from Alue Naga Coastal Waters Banda Aceh). J. Medika Vee., 11(2): 114-117.

Pritchett, K.R. and Sanders, G.E., 2007. Epistylididae ectoparasites in a colony of African clawed frogs (*Xenopus laevis*). J. American Assoc. Lab. Anim. Sci., 46(2) : 86-91(6).

Saptiani, G., C.A. Pebrianto, Agustina, Hardi, E.H. and Ardhani, F., 2017. Short communication : Diversity and prevalence of ectoparasites associated with cultured fish from coal ponds in East Kalimantan, Indonesia. Biodiversitas, 18(2): 666-670.

Sarjito, Haditomo, A.H.C., Desrina, Ferinandika, F.B., Setyaningsih, L. and Prayitno, S.B., 2016. Ectoparasites and vibrios associated with fattening cultured mud crabs (*Scylla serrata* (Forsskal, 1775) from Pemalang Coast, Indonesia. J. Teknol. (Sciences & Engineering), 78:207-214.

Shinn, A.P., Mühlhölzl, A.P., Coates, C.J., Freeman, M.A. and Metochis, C., 2015. *Zoothamnium duplicatum* infestation of cultured horseshoe crab (*Limulus polyphemus*). J. Invert. Pathol., 25:81-86.

Subyakto, S., Suntende, D., Afandi, M. and Sofiati, 2009. Budidaya udang vannamei (*Litopenaeus vannamei*) semi intensif dengan metode sirkulasi tertutup untuk menghindari serangan virus. J. Ilmiah Perikanan dan Kelautan, 1(2): 121-127

Statistics of Gresik Regency, 2011. Gresik in Figure. BPS - Statistics of Gresik Regency. Gresik. 342 p.

Utami, R., 2013. Identifikasi parasit pada udang vanamei di balai besar Pengembangan Budidaya Laut Lampung. J. Budidaya Perairan Fakultas Pertanian Universitas Lampung. 3(2): 12-17 (in Indonesia).

Xinlu, S., Meng, Q., Liu, G., Guilan, Q., Chuanqi, J., Xiangwei, M. and Alan, W., 2014. Morphology and morphogenesis of *Epistylis plicatilis* (Ehrenberg, 1831) (Ciliophora, Peritrichia) from Wuhan, China. J. Morphol., 275(8) : 882-893.

Yuliarti, 2011. Tingkat Serangan Ektoparasit pada Beberapa Pembudidaya Ikan di Makassar. Aquaculture Study Program. Bachelor Thesis. Faculty of Marine and Fisheries. Makassar. Indonesia (in Indonesia).

J.Vet.Parasitol.200-0064-480/$2.50 © IAAVP, India

Ectoparasites of mangrove crabs (Scylla serrata) and white shrimps (Litopenaeus vannamei) from Gresik, Indonesia

ORIGINALITY REPORT

8%	7%	3%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	biodiversitas.mipa.uns.ac.id Internet Source	1%
2	Adamama-Moraitou KK, Alvar J, Assis J, Blavier A et al. "Correlation study and histopathological description of intestinal alterations in dogs infected with Leishmania infantum", 'FapUNIFESP (SciELO)' Internet Source	1%
3	www.atlantis-press.com Internet Source	1%
4	link.springer.com Internet Source	1%
5	ciba.res.in Internet Source	1%
6	S. K. Johnson. "ECTOCOMMENSALS AND PARASITES OF SHRIMP FROM TEXAS REARING PONDS1", Proceedings of the annual meeting - World Mariculture Society, 02/25/2009 Publication	1%

7	Submitted to Universitas Airlangga Student Paper	<1 %
8	Virginia P. Edgcomb, Maria Pachiadaki. "Ciliates along Oxyclines of Permanently Stratified Marine Water Columns", Journal of Eukaryotic Microbiology, 2014 Publication	<1 %
9	journals.utm.my Internet Source	<1 %
10	"The Evolution and Fossil Record of Parasitism", Springer Science and Business Media LLC, 2021 Publication	<1 %
11	Budianto, H Suprastyani, Q A'yunin, Z Nadlifah. " Identification and prevalence of ectoparasites on the fry of Asian sea bass ( ), white shrimp ( ), and blue swimming crab ( ) ", IOP Conference Series: Earth and Environmental Science, 2020 Publication	<1 %
12	D Ningrum, M Arief, dan K T Pursetyo. " Comparative Test on Bacteria in the Digestive Tract of Vannamei Shrimp ( ) at Intensive and Extensive Ponds in Ujungpangkah, Gresik ", IOP Conference Series: Earth and Environmental Science, 2019 Publication	<1 %

13	rdo.psu.ac.th Internet Source	<1%
14	repository.lppm.unila.ac.id Internet Source	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		

Ectoparasites of mangrove crabs (Scylla serrata) and white shrimps (Litopenaeus vannamei) from Gresik, Indonesia

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

RUBRIC: 6TH-8TH SCIENCE ARGUMENT (CER)

CLAIM

Take an arguable position on the scientific topic and develop the essay around that stance.

ADVANCED	The essay introduces a precise, qualitative and/or quantitative claim based on the scientific topic or text(s), regarding the relationship between dependent and independent variables. The essay develops the claim and counterclaim fairly, distinguishing the claim from alternate or opposing claims.
PROFICIENT	The essay introduces a clear, qualitative and/or quantitative claim based on the scientific topic or text(s), regarding the relationship between dependent and independent variables. The essay effectively acknowledges and distinguishes the claim from alternate or opposing claims.
DEVELOPING	The essay attempts to introduce a qualitative and/or quantitative claim, based on the scientific topic or text(s), but it may be somewhat unclear or not maintained throughout the essay. The essay may not clearly acknowledge or distinguish the claim from alternate or opposing claims.
EMERGING	The essay does not clearly make a claim based on the scientific topic or text(s), or the claim is overly simplistic or vague. The essay does not acknowledge or distinguish counterclaims.

EVIDENCE

Include relevant facts, definitions, and examples to back up the claim.

ADVANCED	The essay supplies sufficient relevant, accurate qualitative and/or quantitative data and evidence related to the scientific topic or text(s) to support its claim and counterclaim.
PROFICIENT	The essay supplies relevant, accurate qualitative and/or quantitative data and evidence related to the scientific topic or text(s) to support its claim and counterclaim.
DEVELOPING	The essay supplies some qualitative and/or quantitative data and evidence, but it may not be closely related to the scientific topic or text(s), or the support that is offered relies mostly on summary of the source(s), thereby not effectively supporting the essay's claim and counterclaim.
EMERGING	The essay supplies very little or no data and evidence to support its claim and counterclaim, or the evidence that is provided is not clear or relevant.

REASONING

Explain how or why each piece of evidence supports the claim.

ADVANCED	The essay effectively applies scientific ideas and principles in order to explain how or why the cited evidence supports the claim. The essay demonstrates consistently logical reasoning and understanding of the scientific topic and/or text(s). The essay's explanations anticipate the audience's knowledge level and concerns about this scientific topic.

PROFICIENT	The essay applies scientific reasoning in order to explain how or why the cited evidence supports the claim. The essay demonstrates logical reasoning and understanding of the scientific topic and/or text(s). The essay's explanations attempt to anticipate the audience's knowledge level and concerns about this scientific topic.
DEVELOPING	The essay includes some reasoning and understanding of the scientific topic and/or text(s), but it does not effectively apply scientific ideas or principles to explain how or why the evidence supports the claim.
EMERGING	The essay does not demonstrate clear or relevant reasoning to support the claim or to demonstrate an understanding of the scientific topic and/or text(s).

FOCUS

Focus your writing on the prompt and task.

ADVANCED	The essay maintains strong focus on the purpose and task, using the whole essay to support and develop the claim and counterclaims evenly while thoroughly addressing the demands of the prompt.
PROFICIENT	The essay addresses the demands of the prompt and is mostly focused on the purpose and task. The essay may not acknowledge the claim and counterclaims evenly throughout.
DEVELOPING	The essay may not fully address the demands of the prompt or stay focused on the purpose and task. The writing may stray significantly off topic at times, and introduce the writer's bias occasionally, making it difficult to follow the central claim at times.
EMERGING	The essay does not maintain focus on purpose or task.

ORGANIZATION

Organize your writing in a logical sequence.

ADVANCED	The essay incorporates an organizational structure throughout that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. Effective transitional words and phrases are included to clarify the relationships between and among ideas (i.e. claim and reasons, reasons and evidence, claim and counterclaim) in a way that strengthens the argument. The essay includes an introduction and conclusion that effectively follows from and supports the argument presented.
PROFICIENT	The essay incorporates an organizational structure with clear transitional words and phrases that show the relationship between and among ideas. The essay includes a progression of ideas from beginning to end, including an introduction and concluding statement or section that follows from and supports the argument presented.
DEVELOPING	The essay uses a basic organizational structure and minimal transitional words and phrases, though relationships between and among ideas are not consistently

	clear. The essay moves from beginning to end; however, an introduction and/or conclusion may not be clearly evident.
EMERGING	The essay does not have an organizational structure and may simply offer a series of ideas without any clear transitions or connections. An introduction and conclusion are not evident.

LANGUAGE

Pay close attention to your tone, style, word choice, and sentence structure when writing.

ADVANCED	The essay effectively establishes and maintains a formal style and objective tone and incorporates language that anticipates the reader's knowledge level and concerns. The essay consistently demonstrates a clear command of conventions, while also employing discipline-specific word choices and varied sentence structure.
PROFICIENT	The essay generally establishes and maintains a formal style with few possible exceptions and incorporates language that anticipates the reader's knowledge level and concerns. The essay demonstrates a general command of conventions, while also employing discipline-specific word choices and some variety in sentence structure.
DEVELOPING	The essay does not maintain a formal style consistently and incorporates language that may not show an awareness of the reader's knowledge or concerns. The essay may contain errors in conventions that interfere with meaning. Some attempts at discipline-specific word choices are made, and sentence structure may not vary often.
EMERGING	The essay employs language that is inappropriate for the audience and is not formal in style. The essay may contain pervasive errors in conventions that interfere with meaning, word choice is not discipline-specific, and sentence structures are simplistic and unvaried.