

# Geographic Variation and Species Composition of the Zeiform Fish *Parazen*

Hannah Corcoran and Terry C. Grande



NOAA Okeanos Explorer EX1502 L3 Dive 6

## Abstract

*Parazen* is a monotypic genus (i.e., containing only one species) of ray-finned fishes belonging to the family Parazenidae and the order Zeiformes (Dories). It is a deep-water fish with a geographic locality ranging throughout the Atlantic, Pacific, Indian, and Caribbean oceans. Although *Parazen* is thought to contain only one species (*P. pacificus*), preliminary data based on observed morphological variation correlated with different regions indicates multiple species. This project, by means of 2-D morphometric, and meristic analysis, investigates morphological variation among *Parazen* fishes collected from all recorded oceans to gain insight into the geographic variation of this fish, and whether *Parazen* constitutes more than one species.

## Introduction/Background

The genus *Parazen* is characterized by the presence of a single lateral line, which is what separates it from other Zeiform fishes (Kotlyar, 2001). Due to the large geographic separation between *Parazen* populations (Figure 1), preliminary research has been done to highlight the morphological and molecular difference between *Parazen* of different geographic localities. This research, based on the analysis of the CO1 gene assembled from multiple *Parazen* specimens across its geographic range supports the hypothesis (Figure 2) that *Parazen* may actually encompass more than one cryptic species, and that the observed variation among geographic populations is the result of species boundaries (Tyler et al., 2003). This project is part of a larger research project ongoing by the Grande Lab that involves understanding the evolution of the order of Zeiform fishes (Grande et al., 2018).

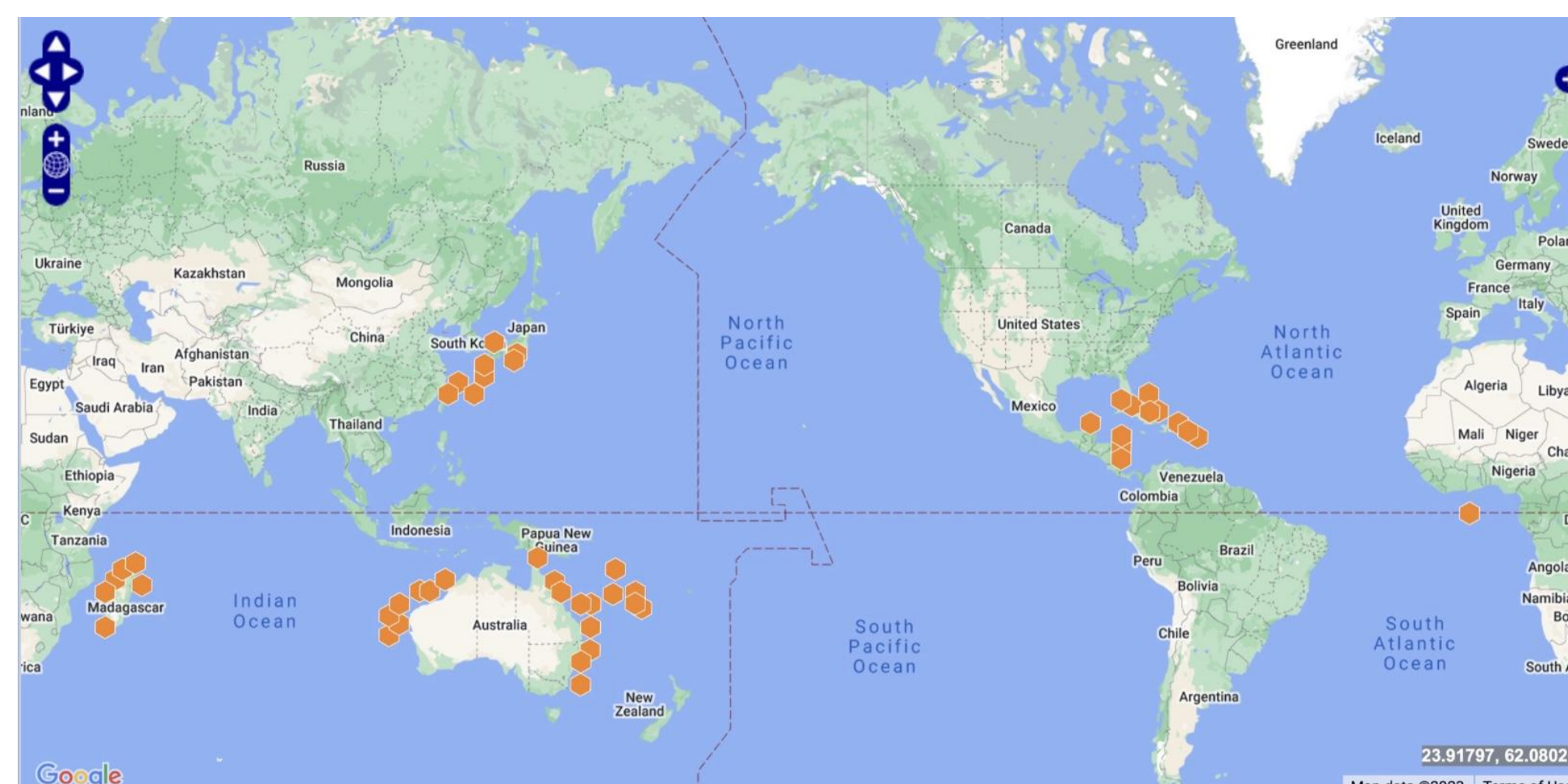


Figure 1. Worldwide Distribution of *Parazen* (Modified Google Earth and Fishnet2 image by Mark V. H. Wilson)

## Research Objectives

This research aims to capture how geographic separation of *Parazen pacificus* may lead to diversification and speciation by means of...

- Quantifying morphological variation within the genus *Parazen*
- Correlating morphological variation with geographic locality
- Determine the species composition of *Parazen* based on the results

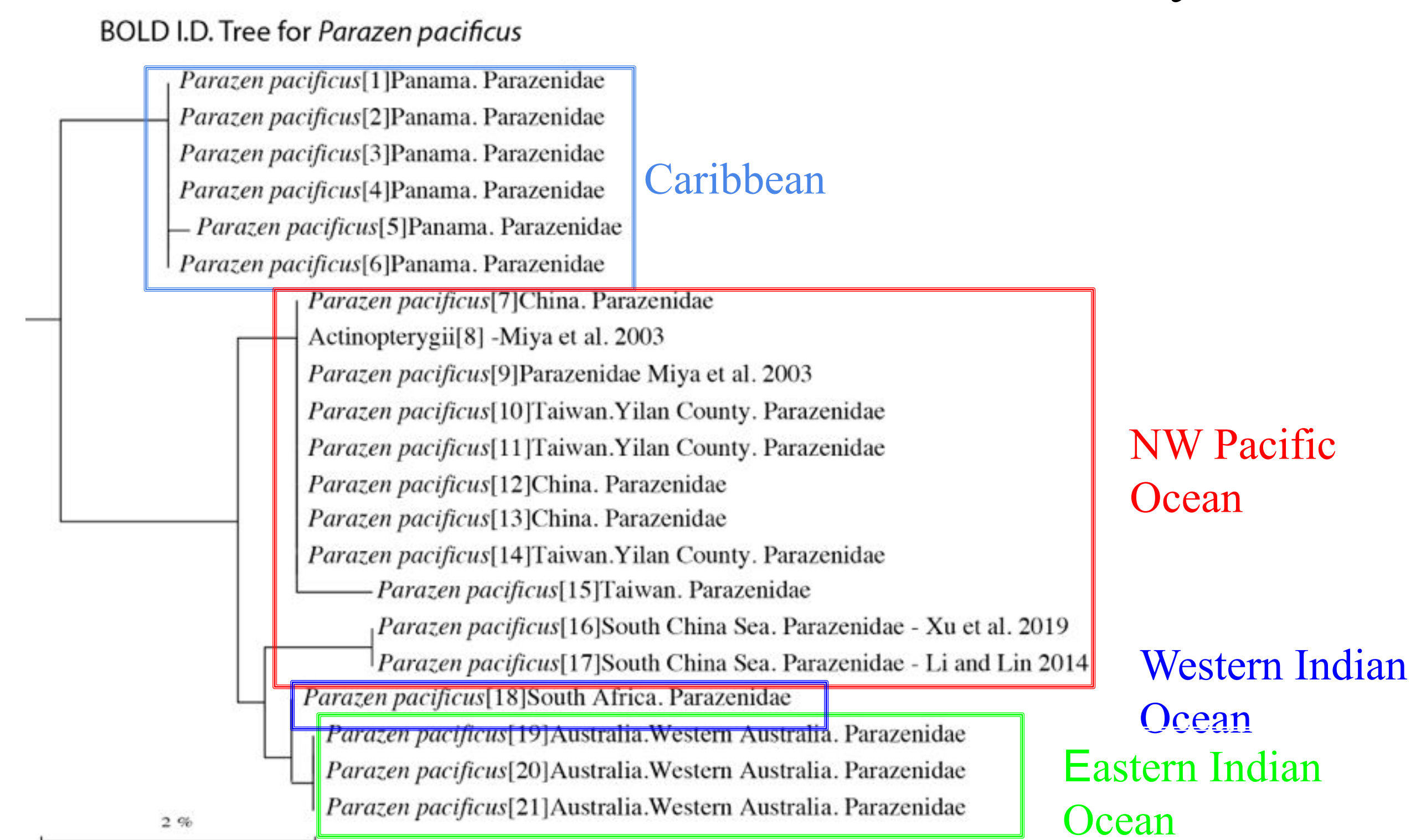


Figure 2. BOLD I.D Tree for *Parazen pacificus* (Singer, Grande, and Wilson)

## Methodology

Data was collected from X-rays of 48 adult *Parazen* specimens from the four known oceans of origin.

### Morphometric Methods:

- Utilizing the plugin PointPicker, 19 landmarks were compared from each specimen
- Landmarks were used to create computer generated graphs of Procrustes fit and principal component analysis

### Meristic and Measurement Methods:

- Meristic data involving number of dorsal and anal spines/rays
- Measurements of areas of interest: Dorsal and anal fin base, standard length.

## Results

### Morphometric Results:

Figure 3. showcases the landmarks marked by PointPicker and compares them between all landmarked specimens. Landmarks appear to be localized to the average, which is indicated by the labeled blue dots.

Figure 4. represents the principal component analysis, which illustrates the morphometric variation of all landmarked specimens and is sorted by geographic locality. Little to no separation seen between Caribbean and Pacific specimens that corroborates preliminary data.

### Meristic and Measurement Results:

Figure 5. is a collection of the measurements of interest and meristic data involving dorsal and anal spines/rays for all 48 *Parazen* specimen. Little to no significant difference is determined based in the measurements of the standard length, dorsal fin base, or anal fin base. Meristic data on the dorsal spines/rays shows slight variation as the Atlantic specimens more often displayed 37 spines, while other specimens displayed between 34-36 dorsal rays/spines.

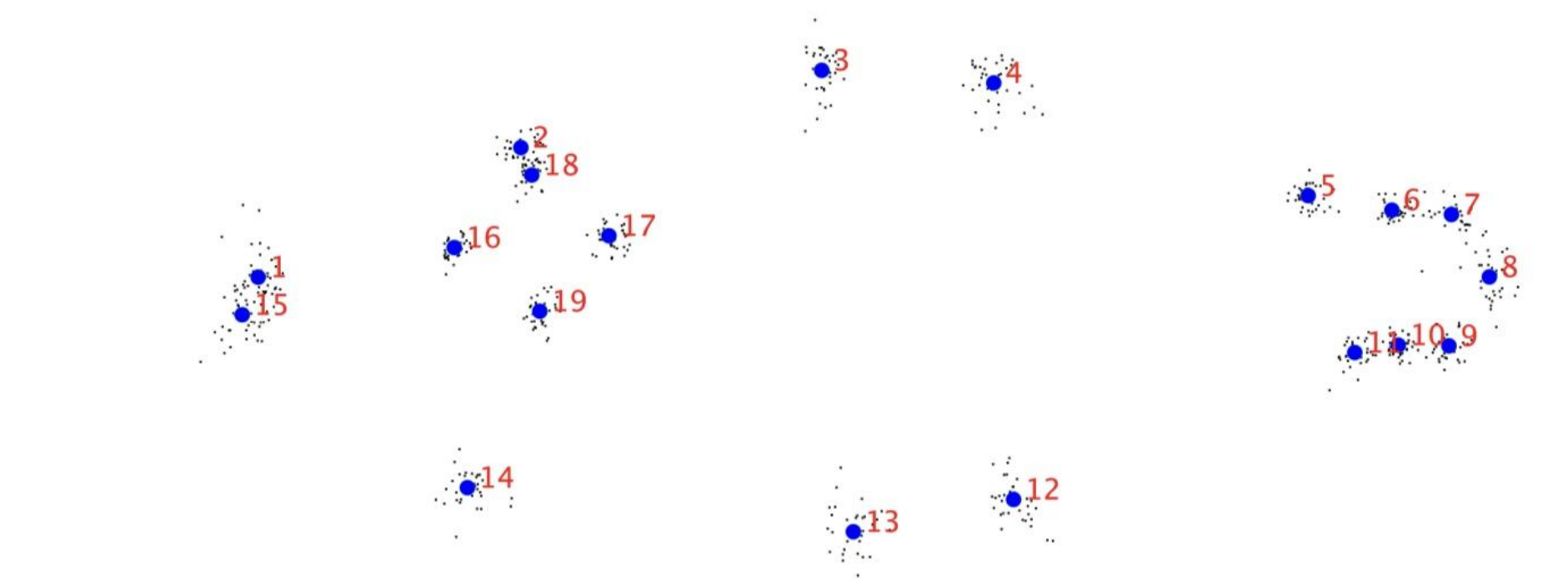


Figure 3. Procrustes Fit of Collected *Parazen* Specimens

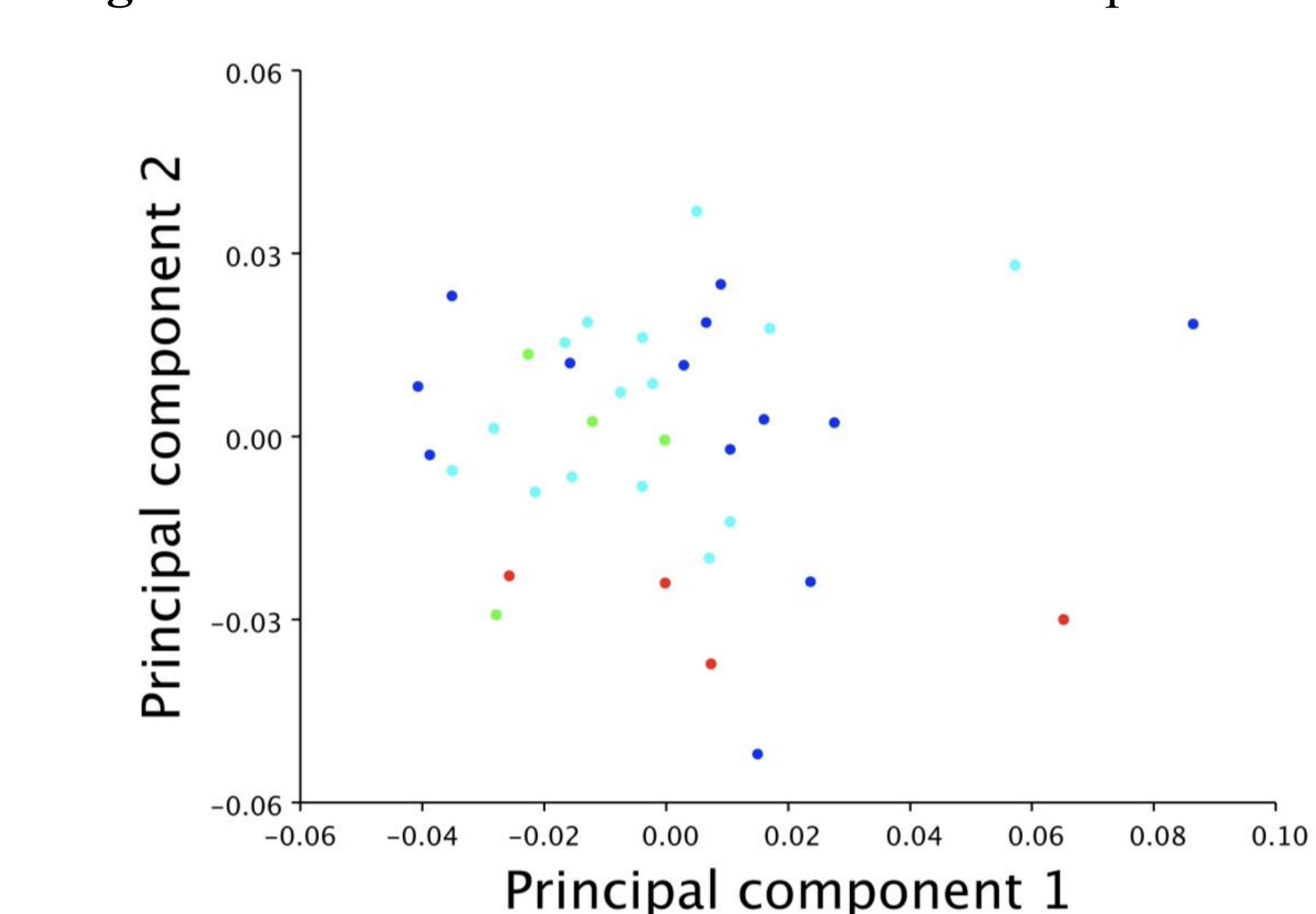


Figure 4. Principal Component Analysis of Collected *Parazen* Specimens

Taxon Name	Catalogue #	Locality	Standard Length	Length of Dorsal Fin Base (cm)	Length of Anal Fin Base (cm)	Length to Dorsal Fin (cm)	Dorsal Spines/Rays #	Anal Spines/Rays #	Vertebrae #
Parazen	USNM 407023	Atlantic	9.04	3.68	2.752	4.55	35	32	34
Parazen	USNM 157874	Atlantic					36	33	34
Parazen	MCZ 49029	Atlantic					36	33	34
Parazen	MCZ 12347	Atlantic (North)	7.362	2.875	2.213	3.54	37	34	34
Parazen	FMNH 6540(top)	Atlantic Puerto Rico					37	34	34
Parazen	FMNH 6540(bottom)	Atlantic Puerto Rico					37	33	34
Parazen	MCZ 49028	Caribbean	10.623	4.213	3.04	5.419	36	32	34
Parazen	FMNH 67101	Caribbean					36	33	34
Parazen	CAS 55167(top)	Caribbean					35	33	34
Parazen	CAS 55167(bottom)	Caribbean					36	33	34
Parazen	USNM 371545 (Specimen c)	Caribbean					36	33	34
Parazen	FMNH 64409(top)	Caribbean					35	32	34
Parazen	MCZ 39370	Caribbean-Cuba	13.144	4.911	3.68	6.918	36	33	34
Parazen	AMS 122821-017 (top L)	Indian (East) Australia	7.764	3.154	2.17	3.978	35	32	34
Parazen	AMS 122821-017 (top R)	Indian (East) Australia	6.638	2.69	2.013	3.257	35	32	34
Parazen	AMS 122821-017 (middle)	Indian (East) Australia	8.483	3.35	2.43	4.245	35	33	34
Parazen	CSIRO H1664-11	Indian (East) Australia					36	33	34
Parazen	CSIRO H14031-57(top)	Indian (East) Australia					35	33	34
Parazen	AMS 133514-005(top)	Indian (East) Australia	13.104	5.035	3.796	6.696	35	33	34
Parazen	AMS 133514-005(2nd)	Indian (East) Australia	14.518	5.746	4.308	7.701	36	33	34
Parazen	AMS 133514-005(3rd)	Indian (East) Australia					35	33	34
Parazen	AMS 133514-005(bottom)	Indian (East) Australia	11.932	4.677	3.651	6.062	36	32	34
Parazen	CSIRO H2556-06 (top)	Indian (East) Australia	10.764	4.253	3.105	5.544	36	32	34
Parazen	CSIRO H2556-06 (2nd)	Indian (East) Australia	8.416	3.083	2.44	4.29	33	32	34
Parazen	CSIRO H2556-06 (3rd)	Indian (East) Australia	8.869	3.212	2.472	4.566	35	33	34
Parazen	CSIRO H2556-06 (4th)	Indian (East) Australia	8.037	2.865	2.259	4.111	34	32	34
Parazen	CSIRO H6413-08 (top)	Indian (East) Australia	10.675	4.201	3.179	5.524	34	33	34
Parazen	CSIRO H6413-08 (2nd)	Indian (East) Australia	10.53	4.385	3.263	5.443	35	32	34
Parazen	CSIRO H6413-08 (3rd)	Indian (East) Australia					36	33	34
Parazen	CSIRO H6413-08 (4th)	Indian (East) Australia					35	33	34
Parazen	MNH 1979-0394	Indian (West)-Madagascar	11.598	4.243	3.385	5.801	36	33	34
Parazen	MNH 1979-0396	Indian (West)-Madagascar					35	33	34
Parazen	MNH 1979-0399	Indian (West)-Madagascar	14.337	5.438	4.292	7.236	35	32	34
Parazen	USNM 118007	North Pacific	13.744	5.581	4.294	6.804	35	33	34
Parazen	CAS 32255	North Pacific- Japan					35	32	34
Parazen	FMNH 120892	North Pacific- Taiwan					36	33	34
Parazen	AMNH 242973	North Pacific- Taiwan	8.58	3.239	2.451	4.515	35	32	34
Parazen	CSIRO H1119-07	South Pacific Australia					36	33	34
Parazen	AMS 120437-001	South Pacific Australia	9.951	4.034	3.084	4.968	35	32	34
Parazen	AMS 120437-001(top)	South Pacific Australia	11.128	4.522	3.553	5.331	36	32	34
Parazen	AMS 20437-001 (bottom)	South Pacific Australia	11.252	4.461	3.59	5.852	35	33	34
Parazen	AMS 125808-003 (top L)	South Pacific Australia	8.277	3.423	2.411	4.219	35	32	34
Parazen	AMS 125808-003 (3rd L)	South Pacific Australia	7.579	3.09	2.273	3.823	35	32	34
Parazen	AMS 121793-001(2nd L)	South Pacific Australia	10.031	3.868	2.942	5.135	36	33	34
Parazen	AMS 20919-006	South Pacific Australia	9.668	3.633	2.808	5.127	35	33	34
Parazen	AM 120437-001	South Pacific Australia	10.842	4.455	3.578	5.27	34	32	34
Parazen	AM 120437-001(2)	South Pacific Australia	11.165	4.524	3.747	5.699	34	33	34

Figure 5. Meristic and Measurement Data of *Parazen pacificus* specimens

## Discussion/Conclusion

The lack of spread between the landmark points in the Procrustes fit graph illustrates an absence of significant variation between the main areas of interest that past researchers have considered to be places of possible diversification. The principal component analysis displays a lack of variation between specimens of the Atlantic and Pacific oceans, and the Caribbean and Pacific ocean which were the main locations of interest due to their large geographic separation. Measurements of the fin bases and standard lengths show little to no difference between specimens of different oceans, which means that if variation is present, it is not displayed in these specific characteristics. There is promise shown in the number of dorsal spines/rays between geographic localities with the Atlantic specimens often having 37 spines/rays, which may reveal speciation of *Parazen pacificus* between the Atlantic ocean and other oceans. These results demonstrate a slight morphological difference between *Parazen pacificus* of different oceans, which may exhibit speciation between specimens with large geographic separations. For future research, additional specimens are needed for tissue collection and DNA sampling. *Parazen* are very deep water and solitary fishes, so they are underrepresented in museum collections. This lack of considerable specimens holds researchers back from doing more in depth studies on the molecular differences of *Parazen* fishes.

## Literature Cited

Grande, T. C., Borden, W. C., Wilson, M. V. H., and Scarpitta, L. 2018. Phylogenetic Relationships among Fishes in the Order Zeiformes Based on Molecular and Morphological Data. *Copeia* 106(1):20–48.

Kotlyar, A. N. 2001. A Rare Zeid Species—*Parazen pacificus*: Osteology, Systematics, and Distribution (Parazenidae, Zeiformes). *Journal of Ichthyology* 41(9):687–697.

Tyler, J. C., O’Toole, B., and Winterbottom, R. 2003. Phylogeny of the Genera and Families of Zeiform Fishes, with Comments on Their Relationships with Tetraodontiforms and Caproids. *Smithsonian Contributions to Zoology* 618, 35 pp.

## Acknowledgements

I would like to thank Randy Singer from University of Michigan for gathering all the specimens and assisting in X-raying them, Mark V. H. Wilson for his assistance in data analysis, and to the various museums who lent us their specimens for our research