

摘 要

随着全球工业的发展，各种微塑料也在逐渐对海洋环境造成污染。作为塑料颗粒的一种，微塑料的直径小于5毫米，形状多样，能够随着季风洋流流入海洋，不能被贻贝等动物消化，其危害要大于一般的塑料颗粒（Eriksen *et al.*, 2014; Ivar Do Sul *et al.*, 2014）。在此背景下，对微塑料污染现状进行了解十分必要。因此，译者在本次翻译实践中选取了两篇环境科学微塑料污染领域的期刊文章，文章名分别为《微塑料和其他人为颗粒在旧金山湾的贻贝中普遍存在，并与多环芳烃没有关联性》和《新西兰绿唇贻贝体内的微塑料》，旨在推动国内相关研究人员知晓贻贝体内的微塑料含量，了解微塑料污染的现状，对其有更加深入的认识。

本报告包括任务说明、过程描述、案例分析、任务评价和结论五部分。首先，译者对翻译文本进行了简要的描述。该翻译材料体现了科技文本严谨、简洁等特征，并含有大量环境科学专业相关的词汇。其次，译者开展了各项准备工作，如建立术语库、准备各类词典、开展文献综述。第三，作者选用功能对等理论，从“词汇对等”、“句法对等”和“篇章对等”三个层面探讨翻译过程中所面临的问题，同时选用恰当的翻译技巧进行翻译。第四，将翻译完成的文本让他人阅读，进行评价。最后，译者对整个翻译过程的结论、不足、建议进行了总结。

本翻译报告聚焦于奈达的功能对等理论在环境科学文本翻译过程中的应用。通过案例分析得出，在词汇层面，可运用直译、意译、增译、减译、转译技巧进行翻译；在句法层面，可将被动句译为无主句，还可以将句子进行分译、合译、重组，从而使译文实现句法对等；在篇章层面，译者可以通过对句子间逻辑关系进行分析、梳理，增加逻辑词，完成翻译任务。

本翻译报告中，译者在功能对等理论的指导下开展了翻译实践，总结了翻译中遇到的问题，整理了三个层次下合适的翻译方法，概括了译者得到的启发，旨在为进一步的研究做铺垫。

关键词：环境科学论文翻译；功能对等；微塑料污染

Contents

1 Task Description.....	1
1.1 Brief Description of the Project.....	1
1.2 Objects of the Report.....	2
1.3 Significance of the Report.....	2
2 Process Description.....	3
2.1 Translation Preparations.....	3
2.1.1 The Establishment of Term Base.....	3
2.1.2 Translation Tools.....	3
2.1.3 Previous Studies on Environmental Science Translation.....	4
2.1.4 Functional Equivalence: An Introduction.....	5
2.2 Quality Control.....	6
2.2.1 Proofreading by the Translator.....	6
2.2.2 Proofreading by the Environmental Science Undergraduates and Masters.....	6
2.2.3 Proofreading by the Supervisor.....	7
2.3 Thesis Schedule.....	7
3 Case Analysis.....	8
3.1 Translation Strategies Based on Lexical Equivalence.....	8
3.1.1 Literal Translation and Free Translation.....	8
3.1.2 Amplification and Omission.....	10
3.1.3 Conversion.....	11
3.2 Translation Strategies Based on Syntactic Equivalence.....	13
3.2.1 Translating Passive Sentence into Non-subject One.....	13
3.2.2 Division and Combination.....	15
3.2.3 Reconstruction.....	16
3.3 Translation Strategies Based on Textual Equivalence.....	18
4 Task Assessment.....	21
4.1 From the Supervisor.....	21
4.2 From Others.....	21
4.3 From the Translator.....	22

5 Conclusion.....	24
5.1 Major Findings	24
5.2 Limitations.....	24
5.3 Suggestions.....	25
References	26
Appendix A: Source Text and Target Text.....	28
Appendix B: Termbase	68
Acknowledgements	71

1 Task Description

In this report, the translation of two environmental science academic articles is recorded. In chapter 1, the translator gives a brief introduction to the translation project as well as the objects and significance of the report.

1.1 Brief Description of the Project

Microplastic is a growing threat to human. Scientists have found the existence of microplastics in human lungs and blood (Leslie *et al.*, 2022; Jenner *et al.*, 2022) . It is necessary to translate relevant articles to protect human health. The source texts include two articles which focus on environmental pollution and the effects on ecosystems and human health published on *Environmental Pollution* and *Marine Pollution Bulletin*. The first article is mainly written by Natasha Klasios from the University of Toronto, Canada and her supervisor Chelsea M. Rochman, a native of Tucson, Arizona from USA. Their research seeks to understand the sources, fate and ecological implications of anthropogenic pollutants in freshwater and marine ecosystems. The second one is mainly written by S. Webb and Sally Gaw from University of Canterbury. The research in their environmental chemistry group, which is interdisciplinary and collaborative, focuses on the fate and behavior of contaminants in the environment including human exposure to contaminants. All of these authors are English-speaking researchers showing great interest in environmental science.

“Microplastics and Other Anthropogenic Particles are Prevalent in Mussels from San Francisco Bay, and Show No Correlation with PAHs” is an article focusing on microplastic pollution in San Francisco Bay by using bivalves as bioindicators. And the second one “Microplastics in the New Zealand Green Lipped Mussel *Perna canaliculus*” is an article focusing on microplastic pollution of a kind of economic ocean animal in New Zealand. Just like any other formal articles, five main parts are included in these two articles. In the abstract, the general content of the text is presented, including background information, the main arguments, research methods and findings, all of which are served as a glimpse of the full text. The introduction gives us a basic picture of marine microplastic pollution and the experimental object of the papers, bivalves, is also presented. The third part introduces the experimental methods. In the results and discussion part, data collected are analyzed from

different perspectives. The conclusion serving as the last part briefly summarizes the final results of the whole paper.

As academic papers, they both reflect typical characteristics of scientific and technological text: (1) Numerous long sentences; (2) Frequently using the passive voice; (3) Plenty of terminologies (韩琴, 2007). Accuracy is of the utmost importance in scientific translation while avoiding the translationese that originates from stiff translation is also a basic requirement for translators when translating (梁春媚, 2014).

The intended readers of these articles can be university students majoring in environmental science or researchers working in institutes or universities. To better meet the requirements in the process of translation, functional equivalence is adopted as guidance when translating.

1.2 Objects of the Report

This report records the whole translation process of the translator. Guided by functional equivalence, several cases are chosen and analyzed from three levels including lexical level, syntactic level and textual level. This report aims to record the problems that the translator faced in the process of translation and to summarize translation skills as guidance for further environmental science translation.

1.3 Significance of the Report.

This report can act as a supplement to previous studies on sci-tech text translation. Although a lot of dissertations discussing sci-tech text translation have been found, there are few discussions on translation in the microplastic area. Reports on the topic of microplastic interpretation are also found, while there's a lack of research on written translation.

The guiding role of functional equivalence theory in microplastic-pollution-related text translating is presented in this report. Some of the target texts translated by the author of this report under the guidance of functional equivalence theory are selected and analyzed. Moreover, the author manages to summarize several translation methods that could be helpful when translating environmental science academic papers at lexical, syntactic and textual level, which acts as guidance for further translation practice in the area of microplastic pollution.

2 Process Description

In this part, detailed information of the translation project is introduced, including term base establishing, translating tools, previous studies on microplastic translation and theory introduction. At the same time, efforts in post-translation process are also described in order to pursue a better quality of the project in revising the translated text.

2.1 Translation Preparations

As the old saying goes, “It is the first step that costs troublesome”. Preparation is of great importance in the whole process of a translation project and is indispensable for every translator. A translator should make sure that everything is well prepared before he launches the translation project officially. Only when he finishes preparing can he focus on translating the source text.

2.1.1 The Establishment of Term Base

For terminology consistency reasons, the translator chooses to use an online term management software called “LingoSail TermBox”, which has the advantage that the same content will not be translated twice so it saves the translator's workload greatly. When establishing the term base, the translator uses LingoSail TermBox to create an initial version. After that, the term base is revised and expanded based on the initial version after the translator himself reads a wide variety of parallel texts. By opening the term base list in Trados, the system automatically identifies which terms are defined in the text and gives a standard translation, which effectively maintain consistency and accuracy of terminology. The term base is shown in appendix B.

2.1.2 Translation Tools

The rapid development of modern technology leads to higher efficiency in working. With the help of computer-aided translation software, translators spend less time on adjusting format and so on, which helps them focus more on translation. In the translation project, the translator uses SDL Trados Studio 2019. Trados can export the translation with the corresponding format and layout to meet the requirements of diversified forms of translation. If the translation is done manually, the translator needs to check whether the format of the translation is consistent with the original, which takes a lot of time and efforts.

While preparing, the translator has purchased or borrowed a number of dictionaries for looking up words including *The English-Chinese Dictionary* and *New Century Chinese-English Dictionary*. At the same time, online tools are utilized for word searching, including DictAll and CNKI dictionary. Besides, CNKI, Elsevier and other academic websites are also used to download parallel texts, all of which are conducive to giving the translator a better understanding of microplastic pollution.

2.1.3 Previous Studies on Environmental Science Translation

Several pieces of research are found on environmental science translation. Most research focuses on term translation or popular text translation.

Hu Chang (2003) discussed environmental science term translation, but the terms mentioned in the article can be seen more often in popular books but not in academic papers. Tao Ling (2016) investigated the back translation of environmental science terms in Chinese-English translation, and the result shows that sometimes translators turn to literal translation unconsciously in term translation. It resulted in a term non-correspondence between the source term in English and the translated term although the translated one seems reasonable at the first glance, indicating that several factors should be taken into consideration in the translation process. Hu Weiwei (2018) categorized environmental engineering terms into five types and summarized suitable methods in the translation process respectively, which are useful too in the translation of terms in environmental science. At the same time, he attached great importance to lifelong learning since new terms in the area of environment have been emerging constantly. Guo Dan (2019) discussed the translation of environmental science-related texts with the help of the translation shifts theory of Catford, and Zheng Hao (2020) discussed the translation of a text related to urban environmental governance based on Nida's functional equivalence theory. Their discussions on environmental science translation hit the spot, but an inappropriate abbreviation appears in both of their dissertations. They explain EST as Ecological Science and Technology and English for Science and Technology. In the area of environmental science, EST should be explained as Environmental Science and Technology, which is the name of a famous journal. Otherwise, it may lead to a huge misunderstanding when researchers or students majoring in environmental science read these dissertations.

In terms of text type, academic paper translation in environmental science can be hardly found. Most of the source texts are popular environmental books in environmental science. Popular environmental books mainly introduce the environmental status to the readers or discuss environmental issues from a social perspective. These texts aim to arouse the awareness of environmental protection in public, and the translator translated them into Chinese in order to let more Chinese people have a sense of environmental protection in their minds. The themes of these texts are of high varieties, such as environmental history of developed countries, policy discussions from social perspective and documentary text (边倩倩, 2020; 姜慧, 2020; 赖铭慧, 2020; 牛文彦, 2020; 曲未豪, 2019; 谭天璇, 2019) .

Therefore, it can be seen that most of the articles focus on term translation or popular text translation in the environmental science area. Hence, there's a blank space in the research of professional English-Chinese translation in environmental science.

2.1.4 Functional Equivalence: An Introduction

The term “functional equivalence” is modified from Eugene A. Nida’s previous theory “dynamic equivalence”. The concept of dynamic equivalence was put forward for the first time in his book *Toward a Science of Translating* (范祥涛, 2006) . The definition of dynamic equivalence translation can be described as “the closest natural equivalent to the source-language message” (Nida, 2004) . By changing “dynamic equivalence” into “functional equivalence” , it aims to eliminate misunderstandings of dynamic equivalence and stress the communicative function of translation in his book *From One Language to Another* (时和平, 1987) .

In the functional equivalence theory, two forms of equivalence are introduced, including formal equivalence and functional equivalence (Nida *et al.*, 2004) . At the same time, the response of the receptors to the translated message is focused. Their response must then be compared with the responses of the readers of the original text (Nida *et al.*, 2004) . One of the most distinctive features of translation is that it tends to satisfy the receptivity of the readers of target language more than creation (杨司桂, 2007) . In Nida’s book named *language, culture and translating*, Nida points out that “Both language and culture are always in the process of change.” Therefore, in the process of translation, factors beyond the

language should also be taken into account while paying attention to the language (叶子南, 2001). Therefore, more attention should be paid to the form and style while the translator trying to reproduce the information of the source language more accurately.

As for the translation practice, the translator should try to reproduce the same response in the target readers as source text readers. Accuracy and fluency cannot be ignored in the target text in order to convey the meaning of the source text precisely, which is in line with the requirements of environmental science translation.

2.2 Quality Control

Proofreading after finishing the translation is an essential step for the translation project towards a higher quality of the text. Although the best translation never exists, we can still carefully polish the translation by proofreading (刘亚猛, 2018). Only after being proofread by people who have a thorough study of translation or students majoring in environmental science, can the translator improve the readability of the translation.

2.2.1 Proofreading by the Translator

Translator himself is the first person who revises the translated text. It should be carefully polished before being proofread by students who major in environmental science and handing it to the supervisor. The translation of several terms is revised, and a number of sentences are adjusted to eliminate translationese. Through these efforts, the translated text looks more like an academic paper written in Chinese than any other style. Mistakes or errors in grammar and logic are also corrected through careful polishing. A lot of time is spent on proofreading.

2.2.2 Proofreading by the Environmental Science Undergraduates and Masters

The potential readers of this translated text are undergraduates and masters majoring in environmental science. Since the translator majored in environmental science during his undergraduate period, it is better to present the text to those who are studying this subject right now. As beginners, undergraduates need to learn knowledge from some basic research in environmental science in a relatively short time with fluent texts that are easy to be understood. Therefore, a number of comments about sentence fluency and readability could be received from undergraduates. In terms of masters, they have a deeper understanding of

environmental science area than undergraduates. Since then, they would be asked if the translation was accurate enough. Only if both of them are satisfied with the translated text can it be considered an excellent one.

2.2.3 Proofreading by the Supervisor

The manuscript is finally presented to the supervisor after being revised by other people shown above. As a teacher specializing in translation, the supervisor has a wealth of knowledge in translation. He can give comments on the revision of the translation from the linguistic, grammatical and other aspects. Based on these comments, the translator launched a new round of improving the translation.

2.3 Thesis Schedule

As shown below, a schedule has been made out before the thesis proposal, which will be strictly followed by the author in the next few months.

Tab. 1 Thesis Schedule

Deadlines	Missions
July 1 st , 2021	Start to write the report.
August 1 st t, 2021	Hand in the 1st draft to the supervisor.
September 1 st , 2021	Receive comments from the supervisor and revise the report.
October 7 th , 2021	Hand in the 2nd draft to the supervisor.
November 1 st , 2021	Receive comments from the supervisor and revise the report.
December 1 st , 2021	Hand in the 3rd draft to the supervisor.
January 1 st , 2022	Receive comments from the supervisor and revise the report.
February 1 st , 2022	Hand in the 4th draft to the supervisor.
March 1 st , 2022	Get ready for the thesis defense.

3 Case Analysis

Translation is a process of solving problems encountered. Only if the translator has a certain amount of knowledge in the relevant disciplines and excellent language skills, aims to strive for excellence in translation quality, could he solve those problems successfully and be considered as a qualified translator rather than an eligible one (文月娥, 2020). To reach this goal in the process of translation, the translator should choose a translation theory as a criteria to guide and judge his translation. Just as the old saying goes, all roads lead to Rome. A proper and suitable theoretical basis is of great importance. After comparing and considering carefully, the translator finally chooses functional equivalence theory as a guidance for the coming translation project. Translation is not a simple transformation, and the importance of translation methods in the process of translation is self-evident (曹国英, 2000). Meanwhile, a translator should master relevant translation skills that are of high efficiency in sci-tech text translation (谷峰, 2017). In chapter 3, several problems encountered at lexical, syntactic and textual levels are recorded, discussed and solved under the guidance of functional equivalence theory by choosing corresponding translation skills.

3.1 Translation Strategies Based on Lexical Equivalence

Word, as the basic unit of language, affects the comprehension of the whole text. In the process of translation, the translator tries to find the closest equivalent in the target language. However, it is difficult to achieve a perfect translation since “no translation is ever completely equivalent” (Nida, 2001). Feasibly, translators may use their translation skills to find words that can make the readers of the translated text have the same response as the readers of the original text.

3.1.1 Literal Translation and Free Translation

There are many technical terms in scientific and technical translation, and compound words are one kind of them. Mostly, literal translation is adopted in the translation of compound words (韦孟芬, 2014). But in some cases, the meaning of any isolated word may be uncertain, so it must be in a specific context so that its meaning becomes clearer and more stable (姜海清, 2004). For words that are polysemous, the meaning of them should be determined based on the discipline background and the overall understanding of the

context in the translator's mind (刘明东, 2001). Here are some examples:

Example 1:

ST: This finding may explain the differences observed between beach sediment samples and green lipped mussels as well as the low abundance of microplastics isolated from the mussels.

TT: 这一发现可以解释在海滩沉积物样本和绿唇贻贝样本之间观察到的微塑料数量差异, 以及从贻贝中分离出的微塑料含量低的原因。

Green lipped mussel is a popular edible seafood from New Zealand, whose scientific name is *Perna canaliculus*. Domestication is not a must when literal translation can realize the extension and connotation of the text (Nida, 2004). In example 1, "green lipped mussels" is composed with the form of "adjective + noun", which is a usual way to name animals and plants (范武邱, 2011). "green" determines the color of the "mussel", which is the core word of the compound word. In the source text, "lip", a word to describe a part of the human body, is used to describe the shape of the core word in its past participle form. Through literally translating adjectives into "绿" and "唇", we can convey the meaning of the word accurately to the intended readers and make the translation as vivid as the source text at the same time, making it easier to be understood by the readers (毛荣贵等, 2003). Therefore, a better equivalence is achieved both in form and style through literal translation in the process of translation.

Example 2:

ST: Using KnowItAll software, spectra were matched to commercial libraries from Bio-Rad, HORIBA and Sigma Aldrich, and in-house libraries 'SLoPP' and 'SLoPP-E' (Munno et al., 2020).

TT: 使用 KnowItAll 光谱解析软件, 将得到的光谱图与 Bio-Rad、HORIBA、Sigma Aldrich 拉曼光谱库, 以及内部拉曼光谱库 SLoPP 和 SLoPP-E 进行匹配 (Munno et al., 2020)。

Context plays an important role in translation. As a text in environmental science, careful consideration is needed in term translation. In example 2, literal translation is inappropriate when translating "libraries" because a lot of common words in our daily life are widely used in the professional field but with other meanings. At first, the translator looks

up the word in the dictionary called *the English-Chinese Dictionary*, but the 9 results found are all inappropriate including “图书馆” and “藏书”, etc. After consulting the dictionary, the translator translates it into “数据库” for the first time. This version achieves formal equivalence, but the meaning of the text is not reproduced truly. “There are, however, some words that never get into a dictionary, for example...rapidly evolving technical terms of science...For translators, encyclopedias are often much more helpful than dictionaries” (Nida, 2001) . Based on this, the translator turns to websites to search for better translation after finding the translation result is not smooth enough. After browsing the official website of Wiley Science Solutions, the translator finds the closest natural equivalent in Chinese, which is, “拉曼光谱库”. Through free translation, the intended readers can understand the meaning of the word, and the translation reproduces the information of the source language from meaning to style in the most appropriate, natural and equivalent language.

3.1.2 Amplification and Omission

In order to better convey the message, in some cases, words need to be added or omitted in the translation. However, regardless of whether amplification or omission is adopted, the basic principle is that the meaning of the words should not be inaccurate or missing when translating. Here are some examples:

Example 3:

ST: In addition, approximately 100 individual bivalves from the transplant and river sites were collected and analyzed for PAHs at SGS AXYS (Sidney, Canada).

TT: 此外，我们从养殖笼和河流中收集了大约 100 只双壳贝类个体，并将样品送至加拿大悉尼市的国际检测机构 SGS AXYS 进行多环芳烃分析。

Sometimes adding word is necessary in the process of translation in order to facilitate readers' understanding. In the example above, if the sentence is translated as “此外，我们从养殖笼和河流中收集了大约 100 只双壳贝类个体，并将样品送至加拿大悉尼市的 SGS AXYS 进行多环芳烃分析”，the readers cannot understand the true meaning of SGS AXYS without searching on the internet. Actually, SGS AXYS, its previous name is AXYS before being purchased by an international third-party institute called Societe Generale de Surveillance S.A. (SGS), which is a company specialized in analyzing Persistent Organic Pollutants (POPs) and Contaminants of Emerging Concern (CEC). Currently, the translated

text achieves formal equivalence, but still needs to be revised. By adding “国际检测机构”, the target text is explicit, and readers do not need to spend extra time on searching irrelevant information online. At the same time, the translated sentence does not look redundant after adding “国际检测机构”. After making some changes moderately, the translator reaches the goal of making the core of the experimental procedure faster and easier for readers to understand, while also reducing the time they spend on searching for unnecessary information. The meaning of the translation is close to the original text so that functional equivalence is successfully realized.

Example 4:

ST: Each digested sample was then poured through a 125 μ m stainless steel sieve and the contents were transferred into a clean polypropylene jar.

TT: 消解后的样品通过孔径为 125 μ m 的不锈钢筛, 将内容物转移至干净的聚丙烯瓶中。

In the example presented, it is a typical passive sentence. In the section of methodology in an academic article, differences can be found in the experimental procedure introduction. In the source text, the sentence is more like a description of the whole experiment from the third person perspective. Since then, “each” is used by the source text author. The translator first translated it into “消解后的每一个样品通过孔径为 125 μ m 的不锈钢筛, 将内容物转移至干净的聚丙烯瓶中”, which is rigid and lacks readability. After reading several parallel texts, the translator finds out that the way of recording the experimental process in Chinese is like recording the complete processing steps of a sample by the experimenter from the first-person perspective. As a result, “each” is omitted in the translated text, which not only conforms to the Chinese expression habit, but also fully shows the professionalism of academic papers. Functional equivalence focuses on the reader’s response. Through adopting omission, the readers of the translated text can reach a level of understanding just as the readers of the original text, achieving functional equivalence.

3.1.3 Conversion

Normalization and passive sentences are abundant in English academic papers (刘英, 2014). Nominalization is concise and well organized, allowing more information to be written in one sentence and making the logical relationship of the sentence clearer and more

detailed (李丙午等, 2002). Verbs dominate Chinese sentences, while in English sentences, nouns dominate especially in scientific English, where nominalization is extremely common (胡密密, 2002). Since then, when translating them into Chinese, conversion at lexical level is needed in order to make sentences smooth. Meanwhile, it can't be ignored that when using nominalization, the responses of the reader should be the same like reading the original text and can't change with part of speech (叶子南, 2007). Here are some examples:

Example 5:

ST: The widespread ingestion of microplastics by animals globally has led many to worry about the risks microplastics pose to populations and communities (Wright et al., 2013; Galloway et al., 2017).

TT: 全球范围内有大量动物摄入了微塑料, 这使许多人担心微塑料对人群和社区产生的风险 (Wright et al., 2013; Galloway et al., 2017)。

Noun verbalization is common in E-C translation. Nouns are widely used as subject, object, predicate, appositive, attributive and adverbial in English (王蕾, 2006). If conversion is not applied, the translated text would be “动物在微塑料上的广泛摄入使许多人担心微塑料对人群和社区产生的风险”, which seems a little strange to read. It sounds weird in the proofreading because translationese occurs in the target text. Therefore, conversion is applied to eliminate the translationese by converting part of speech of “ingestion” from noun to verb, which would make the sentence fluent and smooth in Chinese. At the same time, it helps to reach the goal of reproducing the closest natural equivalent of the source language in the target language.

Example 6:

ST: Raman spectroscopy was used to chemically identify suspected microplastics (Xplora Plus; Horiba Scientific with LabSpec 6 software, see SI 1.2 for instrument settings).

TT: 采用拉曼光谱法识别疑似微塑料的化学成分(设备: Horiba 科学事业部 XploRA Plus 智能型全自动拉曼光谱仪, 光谱分析软件: LabSpec 6, 仪器设置: 见补充材料 1.2)。

In this example, translating without conversion is also inappropriate. “chemically” is an adverb. At the first time, the translator didn't change the part of speech. If the part of speech

of “chemically” is not converted, the sentence will be translated into “采用拉曼光谱法化学地识别疑似微塑料的成分”, which achieves formal equivalence only but sounds extremely strange in Chinese. Before using conversion, the translator adjusts the translated text above to “采用拉曼光谱法从化学层面识别疑似微塑料的成分” in the first place, trying to keep the part of speech unchanged. But after reading parallel texts, the translator finds that such expression is uncommon in environmental professional Chinese. Therefore, conversion is applied after careful consideration. By converting “chemically”, an adverb, into a noun “化学成分”, the translated text with natural expressions meets the common sentence pattern in Chinese, which achieves functional equivalence.

3.2 Translation Strategies Based on Syntactic Equivalence

Scientific English usually uses a large number of long sentences to objectively describe and accurately convey something that happens or occurs in the world of science to explain a scientific term or to describe a process (余高峰, 2012). The sentences are long and complex in scientific English. In the translation of long and complex sentences, the translator should have an in-depth understanding of the meaning of the original text, and then translate it accurately according to the characteristics of the Chinese syntax without being excessively constrained by the structure of the original text (范武邱, 2011).

3.2.1 Translating Passive Sentence into Non-subject One

Passive sentences are common in English, especially in an academic paper (吴雨轩等, 2020). However, there are distinctive differences between Chinese and English. Therefore, when translating scientific texts, the translator should translate them properly by turning them into sentences without a subject. Here are some examples:

Example 7:

ST: The mussel samples were blank corrected by colour-category combination, which was an average of the three lab blanks collected during mussel extraction.

TT: 取贻贝提取过程中采集的三个实验室空白样本的平均值, 按颜色-类别组合对贻贝样品进行空白校正。

The sentence which has a typical sentence pattern in academic papers shown above describes the value in the correction process. The sentence trunk is “The mussel samples were

blank corrected by...”, and the omitted doer is “实验人员”. Preserving the passive sentence pattern is inappropriate in most cases because Chinese expression habits are human-centered. For example, if the translator translate “The mussel samples were blank corrected” directly into “贻贝样品被空白校正”, it does not in accordance with the Chinese language style. In most cases, passive sentence is often used to describe bad things. Meanwhile, if the translator translate it into an active sentence by adding the doer, the translated text would be “实验人员对贻贝样品进行空白校正”. This version may seem to be appropriate, but in an academic article the sentence should be objective in most cases so that we should not add a doer in a sentence unless it is necessary. Therefore, the sentence is finally revised into a non-subject sentence like “对贻贝样品进行空白校正”. Finally, the translated text conveys the meaning of the source text successfully with high fluency, accuracy and readability, having similar functions to each other.

Example 8:

ST: To accurately compare accumulation rates between residents and transplants, transplants would need to be deployed at sites that residents inhabit and be collected simultaneously, and the same species of bivalve should be used.

TT: 为准确比较本地贻贝和移植贻贝的微粒积累速率, 应将移植贻贝投放至本地贻贝的栖息地, 且贻贝品种应当一致, 并同时进行采样。

This is a sentence describing how to increase experimental persuasiveness in the discussion part. The sentence trunk is “transplants would need to be deployed at...”, and the doer omitted in the trunk is “实验人员”. There are three passive voices in the sentence, including “be deployed”, “be collected” and “be used”. The translator translated it into “为准确比较本地贻贝和移植贻贝的微粒积累速率, 研究人员应使用同一品种的贻贝, 将该移植贻贝投放至本地贻贝的栖息地, 并同时进行采样” for the first time, which is an active sentence. The original text is a passive sentence in a subjunctive mood, introducing the requirements in the sample processing. In this circumstance, the translator can translate it into a non-subject sentence or translate it through literal translation or adjusting the word sequence (傅勇林等, 2012). At the same time, when a passive sentence in English does not need to specify the doer, a non-subject sentence can be adopted while translating it into Chinese (傅勇林等, 2012). Finally, the translator translates it again into a non-subject

sentence based on two viewpoints above, which has been shown above in TT already. Moreover, through comparison of the two versions, the translator finds that even if the sentence is a non-subject one, smoothness is retained as well. Therefore, adding the doer is not a must when there is no need to tell the readers the agent of the sentence (何三宁, 2009). Languages can be different in grammar, but they should have the same function. Therefore, the second version is adopted. At the same time, “used” is omitted to ensure convey the complete meaning of the translation since there are too many verbs in the sentence and to achieve functional equivalence.

3.2.2 Division and Combination

In English, many layers of meaning can be usually contained in a single sentence. Such long sentences are usually difficult to express fluently in one Chinese sentence. Therefore, the translator needs to divide the meaning of the sentence and express it in several Chinese short sentences. If the English sentences are short and simple, and there is a connection between them, the translator can try to connect them in logical order, chronological order, etc. Here are some examples:

Example 9:

ST: Because microplastics can sorb PAHs, and thus may act as a source of these chemicals upon ingestion, transplant mussels and resident clams were also analyzed for PAHs.

TT: 微塑料能吸附多环芳烃 (polycyclic aromatic hydrocarbons, PAHs), 而贻贝和蛤蜊又会摄食微塑料, 因此多环芳烃可能会随着微塑料进入生物体内。基于此原因, 本实验也对移植贻贝和本地蛤蜊中的多环芳烃含量进行了测定。

This is a long sentence that is organized logically to explain the reason why PAHs is also analyzed in the experiment. Two adverbial clauses are contained. To translate it, the translator divides the sentence into three parts:

1. Microplastics can sorb PAHs.
2. Microplastics may act as a source of these chemicals (PAHs) upon ingestion.
3. Transplant mussels and resident clams were also analyzed for PAHs.

This division is based on meaning groups of the sentence. The first and the second sentences give a background information of microplastic about its chemical and biological characters. The third sentence is a result, which is inferred from the previous two sentences.

In English, sentence dividing is based on the completeness of grammar, while in Chinese it is based on the completeness of meaning (傅勇林等, 2012). Based on the logical meaning, part 1 and part 2 can be combined together, but part 3 should be translated separately. Then, these three sentences were translated into two fluent Chinese sentences by connecting them with logical words. At the same time, to explain the inner logic clearer, an argument “而贻贝和蛤蜊又会摄食微塑料” is added, which is inferred from the word “ingestion”. By dividing the experimental process into three parts and translating the long sentence into two short sentences, the translated text reproduces the information of the source language from meaning to style in the most appropriate, natural and equivalent language, and it becomes easier for intended readers to understand the original text.

Example 10:

ST: The length and width of each bivalve, in the shell, was measured. The shells were then rinsed with reverse osmosis (RO) filtered water before opening.

TT: 测量了每只双壳贝类的壳内体长和体宽后, 用反渗透过滤水清洗其外壳, 然后开壳。

Example 10 includes two sentences that describe the experimental operation process. They are sequential operation procedures in the sample dissection. At the first time the translator translates them separately, and the translation is “对每只双壳贝类的壳内体长和体宽进行了测量” and “用反渗透过滤水清洗其外壳后开壳”. Although formal equivalence is achieved, these two sentences are not fluent enough when reading them together. At the same time, these two sentences fail to convey the original meaning and style of the source text. In scientific translation, the translator can adjust the division of sentence based on the stages of experimental operation (傅勇林等, 2012). So the translator tries to combine them with “bivalve” as the subject shown above. When these two sentences are combined, the meaning is more coherent and the experimental steps can be explained to the potential reader in a more concise, straightforward and clearer manner than in the separated translation above, expressing the source language information more truly and accurately.

3.2.3 Reconstruction

English sentences are tree-shaped, while Chinese are linear. In English, modifiers, qualifiers, etc., are attached to the trunk. In English-Chinese translation, several verb

constructions can be used to build a linear structure. Meanwhile, when expressing complex meanings, we should introduce them step by step in a logical sequence of time or events, forming a linear structure. Here are some examples:

Example 11:

ST: Suspected anthropogenic microparticles observed were removed from the filter and placed onto double-sided sticky tape mounted on transparent paper.

TT: 准备一张透明纸，贴上双面胶，将观察到的疑似人为颗粒从滤膜上转移到双面胶上。

Example 11 describes the process of transferring the samples. “observed” serves as an attributive to modify the subject “suspected anthropogenic microparticles”, and “mounted on transparent paper” serves as an attributive to modify the object “double-sided sticky tape”. Two prepositional phrases, “from the filter” and “placed onto ... paper”, are used as adverbials to modify two predicates, “removed” and “placed” in this sentence. Based on the analysis above, the sentence is literally translated into “观察到的疑似人为微粒从滤膜中被除去，并放在贴在透明纸上的双面胶带上。”. After proofreading, the translator finds that the core meaning of the sentence is placed at the beginning of the translated text. Basically, in Chinese expressions, important information is presented at the end of a sentence in most circumstances; while in English, it is presented at the beginning. This principle should be obeyed without exception in environmental science translation as well. In this case, the meaning of the attributive “mounted on transparent paper” and the meaning of the adverbial “placed onto ... paper” both imply that paper should be prepared in advance before the experiment, and these two clauses are not the core of this sentence. Therefore, in the process of reconstructing, they are placed at the beginning of the sentence; while “suspected anthropogenic microparticles...were removed” is placed at the end of the target text, serving as the last core step of this experimental operation. Through reconstruction, the translator adjusts the form of the source text to transfer the meaning of the source text based on the operation sequence, taking full account of readers’ understanding of the translation, enabling intended readers to get familiar with basic sample processing better.

Example 12:

ST: Fibers were likely the most dominant morphology observed in bivalves because

their high aspect ratio allows for easy ingestion, but more difficult egestion compared to other morphologies (Ward et al., 2019).

TT:纤维的长径比值高,更易被双壳贝类动物摄食,并且它与其他形态的塑料相比,更难从其体内排出。因此,纤维可能是双壳类动物体内最多的塑料(Ward et al., 2019)。

Example 12 introduces a conclusion cited from other researchers from the original text by the author. “observed in bivalves” serves as an attributive to modify the object “the most dominant morphology”. “Fibers...in bivalves” is followed by “because their...other morphologies”, which is an adverbial clause of reason. In the adverbial presented above, “compared to other morphologies” serves as an adverbial to modify the object “more difficult egestion”. As a sentence in an academic paper, it requires equivalence in content, information and form as much as possible in the translated text, so as to achieve functional equivalence. This is a sentence focusing on logical reasoning so that in Chinese, grounds of argument should be presented in the first place. In terms of sentence structure, using long sentences with complex structures is an important feature of technical English, which aims to express numerous concepts and to make the sentences logical and compact. While translating these sentences, the translator can translate them step by step in a logical order (傅勇林等, 2012). Since that, the translator refines two grounds of argument from the adverbial “because their...other morphologies”, and translates them first based on logical order. They are followed by the final deduction in the next sentence divided by the translator himself. After reconstruction based on the translator’s understanding of the logic of the sentence implicitly reflected in its structure, the translated text is presented to the intended readers in an accurate manner with a linear logical order. In this way, the target text can convey the original meaning of the source text through reconstruction so as to achieve functional equivalence to the most extend.

3.3 Translation Strategies Based on Textual Equivalence

Logical relationships between components of the English language are usually expressed through explicit logical conjunctions (李海军等, 2009). But sometimes the logical relationships between English language components are also implicit in the deep

semantic structure. In scientific English, implicit logical relations may exist at all levels of language, from words to chapters. In the process of translation, the translator needs to clarify these implicit logical relations and make them explicit in the translation with the help of logical analysis, so as to make the translation clearer (白丹妮, 2015).

Example 13:

ST: Samplers were asked to sample 12 *P. canaliculus* of a minimum of 50 mm in length from a similar tidal level. They were asked to avoid exposure to plastics during sampling, and to provide the GPS coordinates of the sample location.

TT: 本实验要求采样者从类似的潮汐水位中采集 12 个长度至少为 50 毫米的绿贻贝。在此期间, 这些采样者不能接触塑料, 同时还要提供采样点的 GPS 坐标。

Example 14:

ST: These preliminary results indicate that further assessment of microplastic contamination of New Zealand coastal environments is warranted. Further work should compare microplastic contamination of filter feeding shellfish as well as sediment dwelling organisms including polychaetes and mud eating gastropods such as *Amphibola*.

TT: 上述研究结果表明, 对新西兰沿海环境的微塑料污染情况开展进一步评估是十分必要的。并且, 接下来的评估应比较微塑料对滤食性贝类以及底栖生物污染, 包括多毛类生物和两栖螺等食泥腹足类生物。

While translating, it is necessary to carefully analyze the various relationships in the original sentences like logical coherence, and then adopt strategies such as copying, changing, adding and deleting according to the Chinese language habits. When dealing with the logical coherence between sentences, it is easy to occur translationese in the target text through literal translation. In example 13, "they" in the second sentence refers to the "sampler" in the first sentence. If it is translated into “他们” literally, the translated text is repetitive and tedious, and the original meaning is not conveyed accurately. By translating "they" into “这些采样者”, the translator not only echoes the content of the original text, but also better conveys the meaning. In example 14, “These preliminary results” is translated into “上述研究结果” instead of “这些研究结果” in order to echo the previous paragraph that introduces a lot of research findings from different scholars. At the same time “并且” is added in the translated text in the second sentence to reflect the progressive relationship with the first

sentence, since the object of the experiment described in the first sentence has been further clarified in the second sentence. At the same time, it makes the target readers have nearly the same reaction while reading. By transferring the information analyzed from the source text to the target text, the sentences are organized logically with stronger connections, which helps the translator better convey the original meaning of the source text. What's far more important is that it also helps the translator construct and output a translation, which conforms to the Chinese expression habit and meets the logical requirements of translation as well.

4 Task Assessment

Task assessment is an indispensable part in the translation project, otherwise the quality of the translation may not be guaranteed and the practical value cannot be revealed. In terms of the translator himself, he can summarize some mistakes he has made and some goals he has achieved, all of which could serve as a translation guidance after examination from other people and himself.

4.1 From the Supervisor

Comments are given after the supervisor receives the translated text: (1) It is feasible to adopt functional equivalence theory in environmental science translation, but the translated text should be further carefully polished; (2) The inner logic of the translated text should be expressed in Chinese more clearly. For example:

ST: Polypropylene jars are used instead of glass as KOH etches the glass introducing glass particles to our samples. KOH does not etch polypropylene, and we do not find polypropylene particles contaminating our samples or our laboratory blanks.

TT1: 使用聚丙烯样品瓶而不是玻璃样品瓶，是因为氢氧化钾会腐蚀玻璃，将玻璃颗粒引入我们的样品中。氢氧化钾不会腐蚀聚丙烯，而且我们没有发现聚丙烯颗粒会污染我们的样品或实验室空白。

TT2: 使用聚丙烯样品瓶代替玻璃样品瓶的原因是，氢氧化钾会腐蚀玻璃，将玻璃颗粒引入样品中，而聚丙烯则不会被氢氧化钾腐蚀。并且，聚丙烯颗粒不会污染样品或实验空白样品。

The translator translates the text into TT1 at the first time. After being proofread by the supervisor, he suggests that the translator can combine these two sentences based on the inner logic of them. So the translator tries to find the inner logic of the two sentences first. These two sentences explain the reason why the researchers select polypropylene jar as the container. After analyzing the inner logic, the translator combines the sentences through logical words such as “而” “并且” as it is shown in TT2. In this way, the sentences are now more closely linked to each other, and the intended readers can comprehend more easily.

4.2 From Others

The translated text is shown to the translator's MTI classmates and schoolmates

majoring in environmental science who have a certain level of English. Several comments are received: (1) The translation reads smoothly in general, and the content of the paper can be understood. (2) Some terms in the translated text are not accurate enough, adjustments should be made. For example:

ST: Now scientists question whether mussels may also be used as indicators for microplastic pollution (Li et al., 2019; Ward et al., 2019).

TT1: 如今, 科学家们提出疑问: 贻贝是否能作为微塑料污染的指标 (Li et al., 2019; Ward et al., 2019)?

TT2: 如今, 科学家们提出疑问: 贻贝是否能作为微塑料污染的指示生物 (Li et al., 2019; Ward et al., 2019)?

At the first time, “indicator” is translated into “指标” as it is shown in TT1. Then, the translated text is being proofread by the translator’s schoolmates majoring in environmental science. They point out that the indicator mentioned above actually refers to mussel, which is a creature. So it is much more better to translate it into “指示生物” instead of “指标”. After reading relevant parallel texts, the translator accepts their advice and revises “指标” into “指示生物” for a better equivalence.

4.3 From the Translator

From the translator's point of view, the translation basically meets the requirements set up at the beginning, that is, translating a text which is suitable for university students majoring in environmental science to read and learn. But since the translator has not yet mastered all kinds of translation skills perfectly, the translated text should be further polished. At the same time, the translator should learn more knowledge about environmental science in order to produce a better translated text. For example:

ST: The lab also has a 24-h HEPA filter system to reduce the potential for cross contamination from the deposition of airborne microparticles.

TT1: 该实验室还有一个二十四小时 HEPA 系统, 以减少空气中微粒子沉积造成交叉污染的可能性。

TT2: 实验室还配置了二十四小时高效空气过滤器 (High Efficiency Particulate Air filter, HEPA) 系统, 以降低样品因空气中微粒沉积导致交叉感染的可能性。

In TT1, the translator does not know the meaning of HEPA and has to translate it literally. However, such a translation would make it more difficult for some readers who do not know the relevant knowledge to understand. Therefore, the translator himself takes the initiative to learn, broadens his knowledge, and searches for the meaning of HEPA by consulting relevant materials, and then explains it more detailly in TT2. In this way, readers don't need to search the Internet to find out what HEPA means.

5 Conclusion

A translator should keep learning from his translation practices. So reflection is a necessary process after the translation. This chapter records the translator's introspection, and the future research direction is also given in this chapter.

5.1 Major Findings

In the translation project, a speculation has been proven to be right. That is, environmental science translation practice guided by the theory of functional equivalence is feasible. In functional equivalence theory, it is required to use the natural and closest equivalent of the source text to convey the meaning, which is also the aim of this project, called environmental science translation.

Through the translation of these two papers in the area of environmental science, strategies for environmental science translation from the perspective of functional equivalence is summarized. In terms of lexical level, literal translation and free translation can be adopted to translate the words when the translator tries to reproduce the response of the reader of the source text. Amplification, omission and conversion can be adopted dynamically when faced with different words. At syntactic level, to clearly express the logical meaning, several methods can be used including translating passive sentence into non-subject one, using division, combination and reconstruction. At the textual level, a number of adjustments are made to meet the requirements in functional equivalence theory.

In the process of translation, the translator should adopt appropriate methods to present a translation that is in accordance with the features of the original text.

5.2 Limitations

Further study is needed to verify whether functional equivalence is achieved in these translation texts. In this report, the author only presents the text to the Chinese environmental science students, and their responses are not collected systematically and scientifically. Meanwhile, no responses are received from English native-speaking university students majoring in environmental science or researchers working in institutes or universities.

5.3 Suggestions

The author summarizes a series of advice for the subsequent environmental science translation. First, preparation before the official launch of the translation project is essential and indispensable. Things will get easier when the translator has a deeper understanding of the area of environmental science, which is also critical to improve the translation quality. Second, theoretical basis is helpful in the process of reproducing. It gives you a criterion to judge whether it is a successful translation. Third, proofreading is a necessary step before the end of the whole project. It gives us a chance to verify whether the text is of high efficiency in conveying messages.

References

- 白丹妮. 科技英语翻译中的隐与显[J]. 中国科技翻译, 2015,28(02):4-7.
- 边倩倩. 《国际环境制度的演变》(节选) 英译汉翻译实践报告[D]. 石家庄: 河北师范大学, 2020.
- 曹国英. 科技英语文献的翻译研究[J]. 中国科技翻译, 2000(01):8-11.
- 范武邱. 科技翻译能力拓展研究[M]. 北京: 国防工业出版社, 2011.
- 范祥涛. 奈达“读者反应论”的源流及其评价[J]. 外语教学, 2006(06):86-88.
- 傅勇林, 唐跃勤. 科技翻译[M]. 北京: 外语教学与研究出版社, 2012.
- 谷峰. 谈科技翻译者的专业素养[J]. 中国科技翻译, 2017,30(01):46-49.
- 郭丹. 翻译转换理论指导下生态科技文本翻译实践报告[D]. 济南: 山东大学, 2019.
- 韩琴. 科技英语特点及其翻译[J]. 中国科技翻译, 2007(03):5-9.
- 何三宁. 实用英汉翻译教程(修订版)[M]. 南京: 东南大学出版社, 2009.
- 胡密密. 从思维差异看汉英科技文体与科技论文的英译[J]. 中国科技翻译, 2002(03):13-15.
- 胡卫伟. 环境工程专业术语翻译探微[J]. 湖南工业职业技术学院学报, 2018,18(03):101-104.
- 扈畅. 环境科学新词试译[J]. 中国科技翻译, 2003(02):53-55.
- 姜海清. 语境与翻译[J]. 外语研究, 2004(05):54-56.
- 姜慧. 《大堡礁环境史》英汉翻译实践报告[D]. 上海: 上海海洋大学, 2020.
- 赖铭慧. 《雾都伦敦: 现代早期城市的能源与环境》(第十二章和第十三章) 英译汉翻译实践报告[D]. 昆明: 昆明理工大学, 2020.
- 李丙午, 燕静敏. 科技英语的名词化结构及其翻译[J]. 中国科技翻译, 2002(01):5-7.
- 李海军, 彭劲松. 逻辑分析与科技翻译[J]. 广西师范大学学报(哲学社会科学版), 2009,45(05):79-82.
- 梁春媚. 科技翻译中的翻译腔: 表现形式及应对策略[J]. 中国科技翻译, 2014,27(03):9-12.
- 刘明东. 语境与英汉翻译中词义的确立[J]. 外语教学, 2001(04):54-57.
- 刘亚猛. 翻译质量评估的理想与现实[J]. 中国翻译, 2018,39(02):8-16.
- 刘英. 英语学术著作的汉译策略[J]. 中国科技翻译, 2014,27(01):8-11.
- 毛荣贵, 范武邱. 形象思维与科技术语翻译[J]. 中国科技翻译, 2003(04):43-46.
- 牛文彦. 《美国环境史》第七、八章翻译实践报告[D]. 北京: 北京林业大学, 2020.
- 曲未豪. 《环境保护主义: 从生物进化和社会演化视角看环境问题》(第二章) 翻译实践报告[D]. 重庆: 四川外国语大学, 2019.
- 时和平. 功能翻译理论的补充与发展——介绍奈达近作《从一种语言到另一种语言》[J]. 中国翻译,

1987(03):42-44.

谭天璇. 《垃圾号一乘风破浪》第十一至十三章选译(英译汉)的翻译研究报告[D]. 昆明: 云南大学, 2019.

陶灵. 环境科学术语汉英翻译过程中的综合回译策略应用[D]. 南京: 南京大学, 2016.

王蕾. 英语构词转类法与英汉翻译词汇转译法[J]. 上海翻译, 2006(03):24-27.

韦孟芬. 英语科技术语的词汇特征及翻译[J]. 中国科技翻译, 2014,27(01):5-7.

文月娥. 傅兰雅的译者素养观及对翻译教学的启示[J]. 中国科技翻译, 2020,33(02):39-41.

吴雨轩, 吴金虎. 冶金工程英语词句特征及汉译探究[J]. 中国科技翻译, 2020,33(04):1-3.

杨司桂. 浅析奈达的“功能对等”理论[J]. 河北广播电视大学学报, 2007(01):68-71.

叶子南. 高级英汉翻译理论与实践[M]. 北京: 清华大学出版社, 2001.

叶子南. 对翻译中“词性转换”的新认识[J]. 中国翻译, 2007(06):52-53.

余高峰. 科技英语长句翻译技巧探析[J]. 中国科技翻译, 2012,25(03):1-3.

郑昊. 功能对等理论指导下的生态类科技文本英汉翻译实践报告[D]. 大连: 大连理工大学, 2020.

Eriksen M, Lebreton L C M, Carson H S, et al. Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea[J]. *PLoS One*, 2014,9(12):e111913.

Ivar Do Sul J A, Costa M F. The present and future of microplastic pollution in the marine environment[J]. *Environmental Pollution*, 2014,185:352-364.

Jenner L C, Rotchell J M, Bennett R T, et al. Detection of microplastics in human lung tissue using μ FTIR spectroscopy[J]. *Science of the Total Environment*, 2022,831:154907.

Leslie H A, van Velzen M J M, Brandsma S H, et al. Discovery and quantification of plastic particle pollution in human blood[J]. *Environment International*, 2022,163:107199.

Nida E A. *Toward a science of translating*[M]. Shanghai: Shanghai Foreign Language Education Press, 2004.

Nida E A. *Language and culture: Contexts in translating*[M]. Shanghai: Shanghai Foreign Language Education Press, 2001.

Nida E, Taber C. *The theory and practice of translation*[M]. Shanghai: Shanghai Foreign Language Education Press, 2004.

Appendix A: Source Text and Target Text

Microplastics and other anthropogenic particles are prevalent in mussels from San Francisco Bay, and show no correlation with PAHs	微塑料和其他人为颗粒在旧金山湾的贻贝中普遍存在，并与多环芳烃没有关联性
Natasha Klasios	娜塔莎·克莱西奥斯
Hannah De Frond	汉娜·德·弗朗德
Ezra Miller	埃兹拉·米勒
Meg Sedlak	梅格·塞德拉克
Chelsea M. Rochman	切尔西·M·罗赫曼
Abstract	摘要
Microplastics are an emerging contaminant of high environmental concern due to their widespread distribution and availability to aquatic organisms. Filter-feeding organisms like bivalves have been identified as particularly susceptible to microplastics, and because of this, it has been suggested bivalves could be useful bioindicators of microplastic pollution in ecosystems.	微塑料是一种新出现的污染物，它分布广泛，且对水生生物而言具有可利用性，因而备受关注。滤食动物(如双壳贝类)尤其容易受到微塑料的侵害。因此，有人认为双壳贝类可以作为指示生物，用于研究生态系统中的微塑料污染状况。
We sampled resident mussels and clams from five sites within San Francisco Bay for microplastics and other anthropogenic microparticles. Cages of depurated mussels (denoted transplants) were also deployed at four sites in the Bay for 90 days to investigate temporal uptake of microplastics and microparticles.	为了得到微塑料和其他人为产生的塑料颗粒，我们在美国旧金山湾区选取了五个采样点，采集了本地贻贝和蛤蜊样品。同时，研究人员在旧金山湾区的四个采样点放置了养殖笼，笼中养有净化过的贻贝(标记为移植生物)。养殖笼放置时长为 90 天，以调查当前贻贝摄入微塑料和微粒的状况。
Because microplastics can sorb	微塑料能吸附多环芳烃

<p>PAHs, and thus may act as a source of these chemicals upon ingestion, transplant mussels and resident clams were also analyzed for PAHs.</p>	<p>(polycyclic aromatic hydrocarbons, PAHs), 而贻贝和蛤蜊又会摄食微塑料, 因此多环芳烃可能会随着微塑料进入生物体内。基于此原因, 本实验也对移植贻贝和本地蛤蜊中的多环芳烃含量进行了测定。</p>
<p>We found anthropogenic microparticles in all samples at all sites, some of which were identified as microplastics. There was no statistical difference between the mean number of microparticles found in resident and transplant species. There were significant site-specific differences among microparticle abundances in the Bay, with the highest abundances observed in the South Bay.</p>	<p>我们在所有取样点的所有样本中都检测到人为产生的塑料颗粒。其中, 部分颗粒为微塑料。本地物种和移植物种的平均微粒数无统计学差异。湾区物种微粒的丰度存在显著的地域差异。其中, 南湾样品中的微粒丰度最高。</p>
<p>No correlation was found between the number of microparticles and the sum concentrations of PAHs, priority PAHs, or any individual PAH, suggesting the chemical concentrations observed reflect broader chemical trends in the Bay rather than direct exposure through microplastic ingestion.</p>	<p>没有发现塑料微粒数量与全部多环芳烃化合物总浓度、需要优先控制的多环芳烃化合物总浓度和每种多环芳烃化合物总浓度之间的相关性。这表明, 测得的化学物质浓度反映了湾区生物摄入多环芳烃的途径广泛, 并非仅通过摄入微塑料直接暴露于多环芳烃。</p>
<p>The pattern of spatial distribution of microparticles in transplanted mussels matched that of sediment samples from the Bay, suggesting bivalves could be a useful bioindicator of microplastic abundances in sediment, but not surface water.</p>	<p>移植贻贝体内微粒的空间分布模式与湾区沉积物样品的相吻合, 表明双壳贝类才是观测沉积物中微塑料丰度的高效指示生物, 而表层水无法达到该目的。</p>

1 Introduction	1 前言
<p>An unprecedented amount of plastic pollution is accumulating in aquatic ecosystems, with an estimated 4.8-12.7 million tonnes entering the environment yearly (Jameck et al., 2015). Much of this plastic debris is weathered down into microplastics, defined as particles smaller than 5 mm (Thompson et al., 2004), through physical and chemical processes (Browne et al., 2007). The global presence of microplastics has been well documented (Cole et al., 2011; Wright et al., 2013), including in the stomach contents of wildlife e recorded in more than 220 species (Lusher et al., 2017).</p>	<p>塑料垃圾正以空前的速度在水生生态系统中累积，每年约有 4800 万—1.27 亿吨的塑料垃圾进入水体环境(Jameck et al., 2015)。大部分塑料碎片通过物理和化学过程 (Browne et al., 2007)被风化成微塑料，即小于 5 毫米的颗粒(Thompson et al., 2004)。在全球范围内有大量的微塑料的检出记录(Cole et al., 2011; Wright et al., 2013)。曾有研究在 220 多个野生物种胃含物中发现了微塑料(Lusher et al., 2017)。</p>
<p>The widespread ingestion of microplastics by animals globally has led many to worry about the risks microplastics pose to populations and communities (Wright et al., 2013; Galloway et al., 2017). The ecotoxicological threat from consumption of microplastics is complex. Across the literature, some studies find adverse biological effects, while others observe no effect (Bucci et al., 2020). Plastic can be a physical hazard causing adverse effects such as lacerations and obstructions of feeding tubes (Derraik 2002; Galgani et al., 2010).</p>	<p>全球范围内有大量动物摄入了微塑料，这使许多人担心微塑料会对人群和社区构成风险 (Wright et al., 2013; Galloway et al., 2017)。微塑料消费背后产生的生态毒理学威胁是复杂的。以往文献中，有的研究观测到不良生物学效应，另一些则没有 (Bucci et al., 2020)。微塑料可能对身体造成物理损伤，导致食道撕裂或梗阻等身体疾病 (Derraik 2002; Galgani et al., 2010)。</p>
<p>Although plastic polymers are inert, plastics are produced with chemical</p>	<p>塑料聚合物虽然是惰性的，但它是用化学添加剂生产的，可从周</p>

<p>additives (Teutten et al., 2009) and can sorb additional pollutants and chemicals, such as polycyclic aromatic hydrocarbons (PAHs) and other persistent organic pollutants (POPs), from the surrounding waters (Hirai et al., 2011; Rochman et al., 2013). Plastic can then act as a vector for the transfer of additives and sorbed chemicals into organisms (Teutten et al., 2009; Pittura et al., 2018). The dual threat of the physical plastic and plastic-associated chemicals may make microplastics more toxic to organisms upon ingestion (Rochman 2013).</p>	<p>围水体中吸收多环芳烃和其他持久性有机污染物(persistent organic pollutants, POPs) (Hirai et al., 2011; Rochman et al., 2013)。因此，塑料可以作为载体，把自身的化学添加剂和吸附的化学物质转移到生物体中 (Teutten et al., 2009; Pittura et al., 2018)。来自塑料及其相关衍生品的双重威胁可能增大微塑料被摄入后对生物体的毒性 (Rochman 2013)。</p>
<p>Some species, depending on their life history strategies, may be more likely to ingest microplastics. For example, filter feeders are directly exposed due to their feeding strategy of filtering particles from the water (Jorgensen 1990). Filter-feeding bivalves, such as mussels and clams, have been identified as highly susceptible to microplastic pollution (Mathalon and Hill, 2014; Li et al., 2016).</p>	<p>以生活史策略为依据可以发现，有一些物种更有可能摄入微塑料。比方说，滤食动物过滤水中颗粒的进食方式使它们直接暴露于微塑料 (Jorgensen 1990)。贻贝和蛤蜊等滤食性双壳贝类，已被确认为极易被微塑料污染影响的物种 (Mathalon and Hill, 2014; Li et al., 2016)。</p>
<p>In fact, mussels are susceptible to contamination by other pollutants. As a result, mussels are used as biological indicators for chemical pollutants (Viarengo and Canesi, 1991) globally in programs such as the US NOAA Mussel Watch Program and CIESM Mediterranean Mussel Watch (Beyer et al., 2017). Now scientists question</p>	<p>事实上，贻贝很容易被其他污染物污染。因此，在美国国家海洋和大气管理局 (National Oceanic and Atmospheric Administration, NOAA) 的贻贝检测计划和地中海国际科学考察委员会 (Commission International Exploration Scientific Mediterranean, CIESM) 的地中海贻贝</p>

<p>whether mussels may also be used as indicators for microplastic pollution (Li et al., 2019; Ward et al., 2019).</p>	<p>检测计划 (Beyer et al., 2017)等项目中，贻贝被用作化学污染物的指示生物 (Viarengo and Canesi, 1991)。如今，科学家们提出疑问：贻贝是否能作为微塑料污染的指示生物 (Li et al., 2019; Ward et al., 2019)?</p>
<p>Building on the research conducted by Sutton et al. (2016; 2019), which quantified microplastic pollution in San Francisco Bay, CA, USA (herein after referred to as the Bay), we quantified the abundance of anthropogenic microparticles in California mussels (<i>Mytilus californianus</i> and a hybrid species of <i>Mytilus galloprovincialis</i> and <i>Mytilus trossulus</i>) and Asian clams (<i>Corbicula fluminea</i>) from this same region. Anthropogenic microparticles, which include microplastics, are anthropogenic particles smaller than 5 mm in size (Sutton et al., 2019). Other examples of anthropogenic particles include dyed cotton, road wear particles and glass.</p>	<p>Sutton 等人 (2016; 2019)对美国加利福尼亚州旧金山湾(以下简称湾区)的微塑料污染进行了量化。我们基于此实验，对来自加州同一地区的贻贝(加利福尼亚贻贝(<i>Mytilus californianus</i>)、地中海贻贝(<i>Mytilus galloprovincialis</i>)和盖勒贻贝(<i>Mytilus trossulus</i>)的杂交种)和河蚬(<i>Corbicula fluminea</i>)中的人为微粒丰度进行了定量分析。人为微粒，包括微塑料，是尺寸小于 5 毫米的人为颗粒 (Sutton et al., 2019)。染色棉、道路磨损颗粒和玻璃都属于人为颗粒的一种。</p>
<p>In addition to quantifying the number of anthropogenic microparticles in resident mussels and clams, we also quantified microparticles in transplanted mussels. These mussels were collected from a marine reserve, allowed to depurate, and then transplanted into different sites around the Bay for 90 days. Transplants were used to measure the rate</p>	<p>除了定量分析当地贻贝和蛤蜊体内人为微粒的数量外，本研究还对移植贻贝体内的微粒数量进行了定量分析。这些贻贝取自海洋保护区，对其净化后移植到湾区附近的若干地点，养殖 90 天。移植贻贝用于测量微粒累积速率。实验对移植贻贝和当地蛤蜊也进行了多环芳烃</p>

<p>of microparticle accumulation. Transplant mussels and resident clams were also analyzed for PAHs.</p>	<p>分析。</p>
<p>The objective of this study was to quantify and compare the abundance of anthropogenic microparticles in resident and transplant species across the Bay and investigate the relationship between PAHs and microparticle abundance. We predicted resident mussels, being older inhabitants of the Bay, would contain a higher number of microparticles per individual when compared to transplant mussels. We also evaluated bivalves as indicators of microplastic contamination in the ecosystem.</p>	<p>本研究的目的是量化和比较湾区本地物种与移植物种中人为微粒的丰度，并探究多环芳烃与微粒丰度之间的关系。我们猜测，由于本地贻贝栖息在湾区的时间更长，所以与移植贻贝相比，其个体体内含有更多微粒。同时，我们还对双壳贝类作为生态系统中微塑料污染指示生物的效果进行了评估。</p>
<p>2 Methods</p>	<p>2 方法</p>
<p>2.1 Sample location</p>	<p>2.1 取样地点</p>
<p>San Francisco Bay is the largest estuary on the west coast of North America. It spans approximately 2575 kilometres and is surrounded by continuous, dense urban areas. The Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) has monitored the water quality of the Bay for over 25 years (SFEI, 2017). The RMP monitors contamination, including legacy pollutants and emerging contaminants, and provides water quality regulators, policy makers, and relevant stakeholders information required to effectively manage the Bay (SFEI, 2017).</p>	<p>旧金山湾是北美西海岸最大的河口，跨度约 2575 公里，四周有连续、密集的城市群。旧金山湾水质区域监测计划(Regional Monitoring Program, RMP 计划)已对湾区的水质进行了 25 年以上的监测(SFEI, 2017)。该计划对遗留污染物、新兴污染物等污染物进行了监测，为水质监管机构、政策制定者和利益相关者提供信息，以求高效管理湾区(SFEI, 2017)。</p>

以上内容仅为本文档的试下载部分，为可阅读页数的一半内容。如要下载或阅读全文，请访问：<https://d.book118.com/456102003205011030>